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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

APRIL 18.

Swansea Technical College Metallurgical Society:—Annual meeting at Swansea.

APRIL 29.

Royal Society of Arts:—Ordinary meeting in London. "Stainless Metals." Paper by Sir Harold Carpenter, M.A., F.R.S.

MAY 7-8.

Iron and Steel Institute:—Meetings in London.

Institute of British Foundrymen.

APRIL 23.

Birmingham, Coventry and West Midlands Branch:—Annual general meeting at Birmingham.

APRIL 23.

Newcastle-upon-Tyne and District Branch:—Annual general meeting. "The Gating and Pouring of Castings," Paper by E. Ronceray.

Forthcoming Congresses.

Coming events are beginning to cast their shadows before. Preparations are in an advanced state for the I.B.F. annual convention in June at Coventry and Birmingham. This should prove an outstanding occasion for reasons geographical, technical and practical, and a good attendance is assured.

In September, the New International Association for Testing Materials will hold its first congress at Zurich. It is of especial significance that in Group A, the division concerned with the metals, cast iron receives first place as a material for discussion. We understand that the organisers have deliberately chosen for international discussion those materials and tests which, by reason of recent developments, are of particular interest, and the choice of cast iron is an independent tribute to the great progress made in it in recent years.

This congress is from September 6 to September 12, and it is particularly fortunate that the International Foundry Congress at Milan follows immediately after, from September 12 to September 27, for those who wish to attend the earlier one will find it convenient to do both. The actual congress at Milan lasts until September 16, the remaining time being devoted to works visits in various parts of Italy.

Details of the programmes have been given in our columns, and we suggest that those of our readers who contemplate going should not make individual travelling arrangements, as parties are almost certain to be arranged for Milan, if not for both Milan and Zurich.

The International Foundry Congress goes to Italy for the first time, and members who attend will be assured of an interesting and valuable visit. Italian engineering has a very high reputation, and it is, of course, one of the great playgrounds and art centres of Europe. It is inevitable that every international congress held should endeavour to outbid its predecessors in interest and range, and we are already assured by the group divisions of the exhibition that our Italian friends who visited Paris, Barcelona, Detroit, London and Liége have taken back ideas and inspiration for their own effort. We are certain that this meeting will be in the very highest degree pleasurable and profitable, and prospective visitors who are planning their summer holidays would do well to keep these dates in mind, and see whether a combination of business and pleasure would not be desirable on this occasion.

A Case for International Co-operation.

Every British foundryman who has the good fortune to receive the latest publication of the American Foundrymen's Association booklet* on the "Testing and Grading of Foundry Sands" will express his admiration at the completeness and thoroughness of the work surveyed. It must be acknowledged that they are the pioneers of this particular phase of foundry research work, and, in the interests of scientific progress, we hope that an effort will be made to make certain of their international acceptance. This would help foundries all over the world to reap a maximum of advantage at a minimum of trouble of any research work on sand carried out anywhere. We are both cognisant and appreciative of the work done by our own Research Association, which has resulted in the production of several different standards, generally admitting of but little work to compare the results obtained with the American standard methods. Though we anticipate the Americans are justly proud of the consummation of their work, we realise that as a nation they are the reverse of being pig-headed, and if the British, French or Germans can show any real necessity for modifying their testing machines or methods for the sake of scientific accuracy, then we are convinced that any official approach will be courteously received and impartially dealt with. Obviously, the sand problems of the various countries are not the same, but it should be borne in mind that the American Foundrymen's Association has had to cater for a continent, and it is reasonable to assume that over such a wide territory vastly differing conditions are bound to exist. Every engineer and metallurgist is appreciative of such standard figures as tensile, elongation, Brinell hardness, specific gravity and so on. Familiarity by foundrymen spread all over the world with easily comparable permeability, fineness and strength data would be a serious factor in the progress of the technique of foundry sands. If the official British foundrymen's organisations possess any real grounds for objecting to the standardised or tentative proposals set forth in this report, they should be presented to the American authorities as soon as possible. In order to make our position quite clear, we would close these remarks by reiterating that our sole object is to render immediately comparable—no matter in what part of the world they originate—any scientific data relative to the testing and grading of foundry sands.

* Reviewed on page 270.

Book Review.

Testing and Grading Foundry Sands.—Published by the American Foundrymen's Association, 222, West Adams Street, Chicago, U.S.A. Price 3 dollars.

This report is an attempt to put into print the steps the American foundry industry has taken to control a raw material of major importance. The introduction tells of the early efforts, the beginning of a national movement in 1920, and sufficient of the results achieved to convince the most sceptical foundrymen of the real benefit to be derived from a co-operative attack on questions vitally affecting their interests.

The first two technical sections are devoted to sampling and preparing for testing, which conform to British notions on the subject, as does Section IV—the determination of moisture. When it comes to permeability testing, which, by the way, is now standardised in America, the British in general have thought fit to modify and in some cases redesign the apparatus.

Provision has been made in the American apparatus for taking care of baked cores and mould-surface permeability. For strength tests only the compression method has been adopted as standard, though four designs of machines are available for breaking the actual specimen. The results are returned as lbs. per sq. in. Here, we suggest, the committee should have published an appendix, which would show that, given a standardised sand mixture, the results really were comparable. The bar, tensile and shear strength testing methods have all reached the stage of tentative standardisation. In connection with the tensile, we are not sure that we care for spring balances in connection with scientific testing.

Section VII carries the subject up to a standard method of fineness testing, choice being given of four types of sieve shakers, and, again, an appendix, proving that with the standardised times of shaking concordant results are given, would be welcome.

Section VIII describes a green-sand mould surface hardness tester, which has been tentatively standardised. This instrument is probably the most useful of all for a jobbing foundry, and has received the scantiest treatment of any, and even the phraseology does not reach the standard of the rest of the report. It is based on the depth of penetration into a mould surface of a *rounded-nose* plunger, 0.2 in. in dia. This "rounded-nose" should surely be described as hemispherical. We feel that the average founder would like this apparatus to be developed so that it could be used as part of a moulder's kit. The methods outlined for chemical analysis appear to be much the same as are used in the average works laboratory and call for no comment.

One of the most important features of this work is the proposed standardisation of a sand, an oil-sand mixture and a baking oven to be used as bases for comparison when making further experiments. Core tests described include the tensile testing of a briquette and the transverse-bar testing. Apart from an excellent bibliography of the subject, which one may regard as an appendix, the closing sections of the report deal with the American standardised system of sand grading, which is based on the four factors of grain-fineness number, grain-fineness class, clay-content class and grain-shape class. In connection with the last, it is extremely interesting to note that the microscope has been used for evolving a standardised description of the type of grain formation. The main features of this book are, to our mind, the amount of work that has been accomplished in ten years, the number of angles from which the subject has been tackled, the absence of any type of elutriation test and the lack of any indication of what the committee consider to be "key" tests. Finally, the members of the American Foundrymen's Association are to be congratulated on the successful co-operative endeavour they have made to place sand testing and grading in its rightful place as a scientific study, instead of a rule-of-thumb operation, incapable of intelligent articulation by its most successful practitioners.

Notes from I.B.F. Branches.

Newcastle and District Branch.—At the commencement of the last meeting of the Newcastle and District Branch of the Institute of British Foundrymen, Mr. A. Logan, the Branch-President, announced the loss to the Branch, by death, of their late treasurer, Mr. Henry Parsons. A letter of condolence had been sent on behalf of the Branch, representatives of which were present at the funeral. A letter of sympathy also had been sent to their secretary, Mr. F. Sanderson, who was seriously ill.

Mr. Logan stated that the next meeting would be held on April 18, when the lecturer would be Mr. E. Ronceray, directeur of the Paris Foundry High School and chairman of the Etablissements Bonvillain et Ronceray, Choisy le Roi (Seine).

West Riding of Yorkshire.—The West Yorkshire Branch of the Institute of British Foundrymen recently paid a visit to the works of Messrs. W. Slingsby & Company, Limited, Woodhouse Road, Keighley. The party was welcomed personally by Mr. Slingsby, head of the firm, and he and members of the staff conducted the visitors over the plant and works, where a certain amount of work had been kept in progress to illustrate the processes.

After the tour of the works, the whole party adjourned to Atkinson's Café, in Locumbe Crescent, Cavendish Street, where tea was enjoyed as guests of Messrs. Slingsby. Mr. H. Sayers (Branch-President) proposed hearty thanks to Messrs. Slingsby for their hospitality and to the staff for their help in the matter. Mr. A. S. Worcester (Senior Vice-President) seconded. Mr. Slingsby responded on behalf of the staff.

Scottish Branch.—The deed of gift and documents in connection with the Sir Archibald MacInnes Shaw Prize, which is being provided by the Scottish Branch of the Institute of British Foundrymen, will be formally handed over at the reception in the City Chambers next Friday by Mr. N. McManus, M.B.E. The Lord Provost will accept the deed on behalf of the Corporation of the City of Glasgow as Trustees of the Prize.

Birmingham, Coventry and West Midlands Branch.—The annual meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen will be held on April 23 at the Chamber of Commerce, New Street, Birmingham, at 7 p.m. Following the business meeting there will be a lecture on "The Gating and Pouring of Castings," by Mr. E. Ronceray, the well-known French foundryman. Those interested are cordially invited to attend the lecture, which will commence at about 7.30 p.m.

Washing Leather Belts.—Numerous cleaning agents are used for washing leather belts, such as naphtha, kerosene, benzol, carbon tetrachloride, aqua ammonia, alcohol, soda and water.

Lining Steel Tubing with Metals Centrifugally.—A new method of lining steel tubing with a variety of metals or alloys is reported from the United States. In combining the inner lining metal with the outer steel shell, the two are claimed to be so bonded by fusion as to be practically inseparable. One of the important advantages claimed for this process is the superiority of the texture of the lining metal, due to its being cast centrifugally.

Random Shots.

"Honoured Sir—from Babujee" is the title of a recently-published compilation of authentic letters emanating from wherever pidgin-English is spoken. Upon the cover is printed a foretaste to the feast—a letter received by a general from the Gold Coast: "Almighty and Spanking Sir one dam black tailor ran away with my wife. Lord God how wonderful." As delightful is a request from Nigeria: "Kindly forward me your gorgeous Catalogue in completement. I shall be one of your customers if you will send it to me indeed. I am at tip toe of expectation. I remain here." And a sign in Korea reads: "G. K. Blank—Bread Baker. The best loafer in Town."

* * *

Perhaps on occasion you glance at the signed and addressed testimonials embodied by patent medicine and food manufacturers in their advertisements. And wonder how Mrs. S—— can unblushingly confide to the world and his wife that "since using your corn cure my weight has fallen from 15 stone to 14 stone 13 lbs." Or how Mr. J—— will allow to be published the confession that "for twenty years I was quite bald. Now, after a month of your treatment, my hair grows so quickly and abundantly that I am compelled to have it cut three times a week. Enclosed is a photograph of myself suspended by the hair from the peaked hat of Nelson's Column." Equally electrifying is a foundryman's printed statement that a certain brand of malted milk keeps him fit. Perhaps it does. I have always staunchly supported the view that fitness and good spirits must go glass-in-hand.

* * *

Agreement is general in the West that the Chinese are a strange race, and apparently agreement is just as general in the East that the English are a stranger race! A Chinese sees and describes us as ununderstandable creatures. His reasons are that "the English live for months without eating a mouthful of rice. They eat bullocks and sheep in enormous quantities. They have to bathe very often. None of them has fingernails more than one-eighth of an inch long. They eat meat with knife and prongs. They never enjoy themselves by sitting quietly on their ancestors' graves, but jump around and kick football, as if they were paid to do it." He concludes triumphantly: "They have no dignity, for they may be found walking with women."

* * *

Imaginary Intimate Interviews.

II.—*The Film Actress.*

Mine is a sad story. A long, long while ago, when I was happy, I was a Civil Service typist, and engaged to a woollen-goods clerk. And then I was dismissed, and because my fiancé couldn't afford to marry I released him from our engagement. Friends in a Streatham amateur theatrical society urged me to go on the films. I went—a virtuous young girl must live somehow. I was a success. I became a star, how I don't know. I hate my work. I would hate my "fans" if I had any, and I haven't. Compared with Greta Garbo or Laura la Plante I'm just a drawing-room entertainer. Perhaps my clean, honest sex-appeal won for me my lead in "Boccaccio's Dream"—a great show. I don't understand men; I never shall. That's why my life has been a beautiful painted tragedy.

Marksman.

The Deterioration of Cast Iron on Repeated and Prolonged Heating.*

By C. E. Pearson, M.Met.

Progress of engineering in recent years has been such as to make heavy demands on foundrymen in the direction of producing irons of high strength, wear and heat resistance, etc. They have proceeded a long way towards meeting these demands. In many respects cast iron has greatly improved in recent years. In the future, irons of still better properties will be required, particularly from the point of view of heat resistance, owing to the tendency to make use of the higher temperatures in many industrial processes.

One of the chief requisites of iron which is to be exposed to heat is that it shall be stable and able to maintain its strength. This may be as important or more so than its initial strength in the cast condition. Among applications of cast iron at high temperatures may be mentioned furnace parts, stoker links, firebars, etc.; moulds and melting pots; and, at lower temperatures, the parts of steam and internal-combustion engines and turbines.

Causes of Growth.

Speaking in general terms, metals decrease in strength and hardness as the temperature is raised, but the loss is temporary and is regained on cooling. This Paper does not deal with this, but with the permanent deterioration which manifests itself, in cast iron that has been heated, in a decrease in tensile strength and hardness, and in permanent increase in volume, usually known as growth.

A study of conditions and causes of growth indicates much about the other forms of deterioration. The fact that grey cast iron is liable to grow when heated has been known at least 150 years. Percy records that some use was made of it to render serviceable cannon balls cast too small. It is convenient to divide the subject of growth into two sections—(*a*) high-temperature growth (600 to 900 deg. C.) and (*b*) low-temperature growth (200 to 600 deg. C.).

Early Scientific Experiments.

The first serious study of high-temperature growth was made by Carpenter and Rugan in 1909. Important conclusions were reached, and they form the basis of our present knowledge. Working mainly at 900 deg. C. they found that *all grey cast irons* grow when heated in air or furnace atmosphere, most rapidly with repeated heating and cooling. *White* cast iron does not grow, unless graphite is precipitated during heating, the presence of graphite being essential. Silicon was found to be a factor of great importance. Under the conditions cited by Carpenter and Rugan, complete growth involves reduction in strength to 25 to 40 per cent. of the original. Growth in oxidising conditions is always accompanied by increase in weight.

Table I.—*Growth of Cast Iron with increasing Si Content. (Carpenter and Rugan.)*

Si per cent.	Growth in air.	Growth *in vacuo*.	Volume of gas evolved *in vacuo*.
1.07	16.1	+ 11.10	1.17 times vol. of iron
1.79	24.0	+ 2.16	1.48 „
2.96	33.6	+ 2.73	0.76 „
4.20	42.8	— 0.19	1.60 „
4.83	57.4	+ 0.15	1.29 „
6.14	67.7	— 0.04	1.11 „

The gases are chiefly nitrogen and hydrogen.

The question next arises whether heating in other types of atmosphere will produce growth. Carpenter and Rugan obtained interesting results *in vacuo*. They are reproduced in Table I.

The pressure exerted by the dissolved gases is possibly responsible for some of the growth occurring *in vacuo*, especially in the lower Si irons, which are closer grained than the remainder.

New Data.

In personal experiments, commercial grey cast irons with 1 to 2.5 per cent. Si gave growths *in vacuo* of from 5 to 9 per cent. by volume, thus closely resembling Carpenter and Rugan's figures. It is interesting to note that Kikuta claims to have found continuous growth *in vacuo*.

The author has also made trials in a hydrogen atmosphere, obtaining, with the same irons, growths between 0.25 and 1.2 per cent. by volume. In more highly-oxidising conditions than are found in furnace atmospheres, for example, in carbon dioxide, growth was extremely rapid, as shown in Table II. No increase in weight occurs during heating in hydrogen or *in vacuo*.

Table II.—*Growth by Volume, per cent. (2.02 per cent. Si).*

No. of heatings.	In air.	In hydrogen.	*In vacuo.*	In CO_2.
1	1.51	0.34	1.88	—
5	3.03	0.92	4.29	12.60
10	8.30	—	5.40	18.45
30	27.00	—	—	—
Final	34.00	1.10	6.02	29.22

The fact that growth occurs in both oxidising and reducing atmospheres, and also *in vacuo*, points to the conclusion that growth has no one simple cause, but is brought about by a combination of factors, each partly responsible. It is worth considering what these may be, since it leads to the possibility of reducing growth.

It is well known that some grey cast irons, when heated, suffer a loss in the amount of combined carbon which they contain, the carbon being precipitated almost certainly on the pre-existing graphite flakes. This decomposition of Fe_3C has been suspected as a possible cause of growth. Carpenter and Rugan have calculated the increase in volume which would result from the complete decomposition of the Fe_3C in a white cast iron (3 per cent. carbon). They give this as 2.88 per cent. In grey cast iron, the loss in combined carbon rarely exceeds 0.6 per cent., which would cause less than 1 per cent. growth. Obviously this is inadequate to explain the large increases in volume actually experienced. However, it probably accounts for *some* of the growth at high temperatures, and, as we shall see, is almost certainly the *chief* cause of growth at low temperatures. There is no doubt that, in any case, it causes a marked decrease in strength, as will be seen from slides. The part played by gases has been referred to; they must be saddled with some responsibility, particularly in the case of close-grained irons. Neither of the above explanations will account for the increases in volume of 15 to 40 per cent. experienced in commercial grey irons, under oxidising conditions. That they are found in oxidising conditions, and, moreover, occur most rapidly in highly oxidising atmospheres, clearly indicates some form of internal oxidation as an important cause of growth.

Microscopic Evidence.

Microscopic examination of samples at various stages of growth is of help in this direction. After one or two heatings at 900 deg. C. for one hour, samples are found to have, near their outside edges, an enlarged or swollen form of graphite flake. With further heatings this phenomenon extends towards the centre of the bar, and when it occurs there the growth is complete; by this time the graphite at the edges of the bar is surrounded by small cracks. Later still the graphite disappears completely by oxidation and is replaced by oxide areas. What probably occurs is that the furnace gases find a way into the outer layers of the iron along the graphite flakes. There they oxidise the silico-ferrite, causing the formation of oxide envelopes round the graphite, giving it a swollen appearance. In time, which depends on how oxidising the gases are, the passages become choked by oxide, and further penetration is thus delayed, unless the iron is then cooled, in which case the stresses set up due to contraction and to the volume changes on passing the critical points, cause the formation of cracks round the graphite and the associated oxide; new passages are thus opened up, and on again heating the gases penetrate further. This, then, is a possible mechanism by which repeated heating and cooling may cause growth at high temperatures.

It is natural to inquire what will be the effects of the other elements normally present in, or which may be added to, cast iron. It has been shown that carbon in the form of graphite is essential for the occurrence of growth. It is probable that the greater the amount present, the more rapid will the growth be. The form, size and distribution of the graphite flakes is undoubtedly a factor to be considered.

Influence of Elements.

Opinions are variable as regards the effect of Mn. Carpenter and Rugan found it to decrease growth slightly. In the amounts usually present, sulphur is not important in this connection. Phosphorus has a decided influence, 0.3 per cent. will decrease growth by 3 per cent. In the case of nickel, the evidence is contradictory; Andrew and Hymen found it to behave like silicon in promoting growth. Donaldson also found it to bring about growth at low temperatures. Piwowarsky and Freytag, on the other hand, say that in amounts up to 5 per cent. it is not harmful. Chromium is beneficial and reduces growth. A difficulty in using it arises from its tendency to produce chill, though this may be met by the addition of nickel.

Reviewing the position, it is desirable to inquire how the growth is to be prevented or reduced. It is natural to look towards low-silicon irons, since Si is such a powerful factor in causing growth. But silicon cannot be reduced much below 1 per cent., even in heavy sections without producing chill. A way out of this difficulty has been opened up by the development of the Lanz process, by which pearlitic grey iron, containing silicon as low as 0.5 per cent. can be successfully produced. Through the courtesy of Mr. Gresty, of North Eastern Marine Engineering Company, Limited, the author was able to make tests on two Perlit irons produced by this process. The first, contained 0.68 per cent. Si, showed a growth of 5.49 per cent. by volume; the second, containing 0.48 per cent. Si, gave a growth of 2.83 per cent. These growths were less in both cases than would have been anticipated from a consideration of their silicon contents. Possibly this is due to a low-gas content, owing to the slow cooling of the irons in heated moulds, which is a feature of the process.

Effect of Graphite Formation.

As an alternative method, it is claimed by Piwowarsky that growth is much retarded in irons which have been superheated prior to

* A Paper read before the Newcastle Section of the Institute of British Foundrymen, Mr. A. Logan presiding.

casting, owing to the form of the graphite distribution. Irons, in which growth is extremely slow, may, in some circumstances, be just as useful as irons of low total growth. Finally, it may be possible to make use of alloy cast irons. Andrew and Hymen found an iron with 1.15 per cent. Cr (1.37 per cent. Si) grew less than any other iron experimented with. Still higher proportions of chromium, with, say, nickel additions to preserve greyness, may prove to be economically justifiable.

Turning next to the lower range of temperature between 200 deg. and a maximum of 600 deg. C., which covers the conditions obtaining in engine practice, it is found that the position with regard to deterioration of properties and growth has been cleared up in recent years largely by the researches of Donaldson. That growth was known to occur at comparatively low temperatures is shown by Carpenter's reference in 1909 to the tendency of superheat steam nozzles at 350 deg. C. to close up due to growth.

Quite apart from growth, it has been recognised for some time that a decrease in combined carbon could occur in cast iron heated to temperatures even below 600 deg. C., with consequent loss in strength. Donaldson's and Campion's early experiments were made at temperatures of 450 and 500 deg. C. in atmosphere of coal gas. The growths and fall in strength met with showed that the subject was of importance. A number of further investigations have since been made, all of which have gone to show that the irons which grow and are weakened by heating at low temperature are those in which decomposition of Fe_3C occurs, during the heating. As already mentioned, this is almost certainly a cause of growth at high temperatures.

Combined Carbon and Growth.

The next question then is, which irons will lose combined carbon on heating and thus be liable to grow, and which will remain stable? Hurst has shown that the chief factor is the amount of silicon in the iron, and Donaldson has shown that a further consideration is the total amount of carbon in the iron, the greater the amount the greater the loss of combined carbon. Information is available to show the loss in strength accompanying loss in combined carbon on heating at 450 deg. C. in irons of varying silicon content, and to demonstrate the relationship between silicon and carbon contents and amounts of growth.

It appears to be true that whereas repeated heating and cooling is most efficacious in producing growth at high temperatures, continuous heating is just as effective at low temperatures. It is, at present, an open question whether oxidation plays any part in producing low-temperature growth. Some authorities, while recognising the part played by the decomposition of Fe_3C, are of opinion that steam and other gases do penetrate the iron and produce internal oxidation. The general consensus appears to be that oxidation may occur, more especially in those irons which show loss in combined carbon on heating.

Effects of other Elements on Low-Temperature Changes in Iron.

Phosphorus, since it has a slight stabilising effect on Fe_3C, is probably beneficial.

Manganese is useful in restraining the breakdown of Fe_3C, but even large amounts will not completely prevent it.

Nickel, like silicon, accelerates decomposition of Fe_3C.

Chromium has a powerful stabilising action. Irons containing it may show shrinkage.

In conclusion, since the irons made by the Lanz process proved themselves so highly resistant to the effects of temperatures of the order of 900 deg. C., it will be of interest to refer to the more recent experiments by Donaldson, in which these irons have been compared with other irons. The Perlit irons were found to be considerably more stable than irons of higher silicon content, only slight changes in the amounts of combined carbon being found. It is important to note that none of the irons dealt with showed any appreciable deterioration below 300 deg. C. The Perlit irons gave the least growth, in one case this amounted when complete to only 0.06 per cent. at 550 deg. C.

Iron and Steel Institute.

PROGRAMME OF ANNUAL MEETING.

The Annual Meeting of the Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, May 7 and 8 next.

THURSDAY, MAY 7.

The general meeting of members will open at 10 a.m., when the annual report and statement of accounts for 1930 will be presented, and members will be asked to confirm amendment of the Bye-laws by adoption of a new Bye-law, namely:

"No. 37.—The income and property of the Institute and the income of any funds held in trust by the Institute shall be applied solely to the promotion of the objects of the Institute, and no portion thereof shall be paid or transferred directly or indirectly by way of dividend, gift, division, bonus or pecuniary profit, unto or between any of the members of the Institute. Provided that nothing herein contained shall prevent the payment in good faith of reasonable and proper remuneration to any officers or servants of the Institute or of payment to any member of the Institute in reimbursement of expenses properly incurred by him on behalf of the Institute."

Election of new members will follow. The newly-elected President (Colonel Sir Charles Wright, Bart., K.B.E., C.B.) will then be inducted. After the presentation of the Bessemer gold medal to Sir Harold Carpenter, F.R.S., Sir Charles Wright will give his presidential address.

Papers Nos. 5 and 15 (see appended list) will then be presented for discussion.

At 2.30 p.m. the afternoon session will commence, and Papers Nos. 1 and 13 will be presented for discussion.

In the evening, at 7.30 p.m., the annual dinner of the Institute will be held in the Grand Hall, Connaught Rooms, Great Queen Street, W.C. Applications for tickets (price 15s. each, excluding wine) should be sent in not later than April 30.

FRIDAY, MAY 8.

At 10 a.m. the general meeting will be resumed. An announcement of the award of the Andrew Carnegie Research Scholarships for 1931-32 will follow, as well as an announcement of the award of the Carnegie gold medal to Dr. E. Valenta (Skoda Works, Pilsen). The award of the Williams prize to Mr. Frank Bainbridge (Saltburn-by-the-Sea) will also be made.

Papers Nos. 16, 8 and 11 will be presented for discussion. The afternoon session will commence at 2.30 p.m., where Papers Nos. 9, 6, 2 and 10 will be presented and discussed.

The following Papers will be presented at this meeting and discussed by correspondence, viz.: Nos. 3, 4, 7, 12 and 14.

Papers to be Read at the Meeting.

The following is the complete list of Papers offered for the May meeting:—

(1) "First Report on the Corrosion of Iron and Steel," being a report by a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers to the Iron and Steel Industrial Research Council.

(2) "The Sub-Crystalline Structure of Ferrite," by C. O. Bannister and W. D. Jones.

(3) "The Formation of Ferrite from Austenite," by Sir H. C. H. Carpenter, F.R.S., and J. M. Robertson.

(4) "Refractory Materials for the Induction Furnace," by J. H. Chesters and W. J. Rees.

(5) "Production Economy in Iron and Steel Works," by O. Cromberg.

(6) "Blast-Furnace Data and their Correlation.—Part II," by E. C. Evans, L. Reeve and M. A. Vernon.

(7) "The Resistance of Copper-Nickel Steels to Sea Action," by J. Newton Friend and W. West.

(8) "On the Nature of Defective Laminations in Wrought-Iron Bars and Chain Links," by H. J. Gough and A. J. Murphy.

(9) "The Basic Process: Some Considerations of its Possibilities in England," by V. Harbord.

(10) "Some Alloys for Use at High Temperatures. Complex Iron-Nickel-Chromium Alloys. Part III.—The Effect of Composition and Exposure to High Temperatures," by C. H. M. Jenkins and H. J. Tapsell.

(11) "The Effect of Carbon and Silicon on the Growth and Scaling of Grey Cast Iron," by A. L. Norbury and E. Morgan.

(12) "X-Ray Investigations on the Crystal Structure of Hardened Steel," by E. Ohman.

(13) "The Constitution of Scale," by L. B. Pfeil.

(14) "X-Ray Investigation of Certain Nickel Steels of Low Thermal Expansion," by G. Phragmen.

(15) "The Melting Shop of the Appleby Iron Company, Limited," by A. Robinson.

(16) "Accelerated Cracking of Mild Steel (Boiler Plate) under Repeated Bending," by W. Rosenhain, F.R.S., and A. J. Murphy.

Members who wish to contribute by correspondence to the discussion on any Paper should send in their communications by June 1.

AUTUMN MEETING.

September 29 to October 1, 1931.

The Autumn Meeting of the Institute will be held in Swansea, under the Presidency of Colonel Sir Charles Wright, Bart., K.B.E., C.B., on Tuesday to Thursday, September 29 to October 1 (not September 22 to 24, as previously announced).

The following is an outline of the provisional programme:—

Tuesday, September 29.—*Morning:* Technical Session. Lunch by kind invitation of Messrs. The British (Guest Keen & Baldwins) Iron & Steel Company. *Afternoon:* Visit to the Port Talbot Works of the British Iron & Steel Company. *Evening:* Reception by the Mayor of Swansea, followed by a dance.

Wednesday, September 30.—*Morning:* Technical Session. Lunch by kind invitation of Messrs. Baldwins, Limited. *Afternoon:* Visits to King's Dock Tinplate Works of Messrs. Baldwins, Limited, and to the Works of the Grovesend Steel & Tinplate Company, Gorseinon. *Evening:* Banquet by kind invitation of the South Wales Siemens Steel Association.

Thursday, October 1.—*Morning:* Technical Session. Lunch by kind invitation of Messrs. The National Smelting Company and Messrs. The Anglo-Persian Oil Company. *Afternoon:* Visits to the South Wales Spelter Works, Swansea; The National Oil Refineries, Skewen, and the Mond Nickel Works, Clydach. *Evening:* Welsh musical entertainment at the Patti Pavilion, Swansea, or at the Pier Pavilion, Mumbles.

On one of the afternoons, Mrs. Henry Folland, J.P., will entertain the ladies to a Garden Party at "Llwynderw," Swansea. Visits to the beauty spots of Gower will be arranged for the other afternoons. The meetings, lunches, and the evening functions on Tuesday and Wednesday will be held in the Drill Hall, Swansea.

Further details or modifications will be published in due course.

Institute of Metals.—The twenty-first Annual May Lecture of the Institute of Metals will be given on Wednesday, May 6, by Mr. William B. Woodhouse, M.Inst.C.E. (engineer and manager, Yorkshire Electric Power Company), on "The Progress of Power Production." Tickets may be obtained from the secretary of the Institute, Members' Mansions, Victoria Street, London, S.W.1.

Commercial Tests for Cast Iron.*

By H. W. Swift, M.A., B.Sc., M.I.Mech.E.

The ultimate purpose of a commercial test on any material is to determine whether or not it is suitable for its particular purpose. Cast iron is used for many diverse purposes, requiring many different qualities in the metal, and it should therefore be obvious that no one method of testing can possibly cover all conditions. It is of importance not to lose sight of this principle, even although it may not always be possible to carry it out in practice. In the past there has been too great a tendency to measure the quality of cast iron for all purposes in terms of the transverse strength of a 1-in. by 1-in. by 12-in. bar. There are at least five different reasons for which a casting may be consigned to the scrap heap. It may fracture, due to excessive tensile stress or due to excessive strain. It may become worn to such an extent that it ceases to perform its function properly. It may become corroded away; or it may be rejected owing to unsoundness or porosity. It does not follow that an iron which has good mechanical strength will necessarily wear well, resist corrosion, or make a sound casting of variable thickness.

In a perfect world, each source of failure would demand separate consideration. Yet at the present time there is no standard test for cast iron other than a test of mechanical strength. There is no doubt that in theory satisfactory forms of test could be devised which would cover all the possible sources of failure and so reduce the element of trial and error in the production of castings. In the past the engineer has been prone to regard the foundry as little more than a quarry for rough and ready raw material, but with the advance in foundry practice during the last few years the engineer has been forced to change his attitude, and the potential range of usefulness of cast iron in the future seems almost unlimited. With such vast unexplored possibilities ahead it behoves all interested in the future of cast iron to free themselves from the traditional views on testing and to study it from a more fundamental and more rational standpoint. Granted this wider point of view, there should be no insurmountable difficulty in developing methods which can be relied on to test any of the properties of cast iron which happened to be important for any particular application, and which could be carried out under commercial conditions in a well-equipped foundry or engineering works. But such methods can only be developed in the light of a wider and deeper understanding of cast iron than exists to-day, and any attempt to put forward suggestions at the moment would be more speculative than scientific. There are four basic mechanical tests of cast iron. They are: the tensile test, the compression test, the hardness test and the transverse test.

The Tensile Test.

Tensile strength is usually regarded as the most important property of cast iron so far as the finished product is concerned, and the large majority of fractures which occur in service are due directly to tensile failure. Tensile strength can only be determined by means of the direct tensile test, which may be carried out either on an ordinary testing machine, or by means of special attachments on some transverse machines. With a brittle material like cast iron it is essential that the load shall be applied along the central axis of the bar; otherwise bending action is induced and an abnormally low result obtained. For this reason the bars must be accurately centred before the ends are screwed, and special grips should be employed to ensure that a truly axial load is applied in the testing machine. The Robertson type of grips are excellent for this purpose, though they cannot be used in all machines owing to the room they occupy. For larger specimens spherical-seated washers have been employed with some success.

When the tensile test is properly carried out, the bar breaks straight across at the weakest cross-section. As a rule there is some element of unsoundness in any cast bar, and the very fact that a number of tests on bars cast under identical conditions often give considerably different results is evidence that fracture more often occurs near a small flaw than across a perfect section. Moreover it is found that the tensile strength of a bar is generally improved by machining away the strong close-grained metal near the skin. This is undoubtedly due to the fact that flaws and dirt are most liable to be found close to the skin, which is nearest to the source of foreign material and gases and is the first part of the bar to solidify. For these reasons it seems clear that the tensile test should be regarded as a test of soundness in the test bar rather than a measure of the intrinsic strength of the metal in the castings, and whether or not it is a safe criterion of the soundness of the metal in the castings is also a matter for consideration.

The Compression Test.

Although it is one of the primary laws of design that cast iron should, as far as possible, be kept in compression, there is no standard crushing test and no demand for such a test for commercial purposes. This is partly due to the fact that cast iron is four or five times as strong in compression as it is in tension, and partly to the fact that the crushing test does not show up unsoundness in the material. Nevertheless, as a test for intrinsic strength as opposed to soundness, it is of considerable importance, and it is easily carried out in an ordinary testing machine on short cylindrical specimens cut from a broken tensile bar.

The Hardness Test.

Hardness is properly defined as the resistance of a material to indentation, though attempts have been made to apply it to the resistance to wear. It may be stated at once that resistance to indentation and resistance to wear are by no means synonymous or even closely related, and as a measure of durability any ordinary indentation test, such as the Brinell test, is almost worthless. The indentation test is alternatively put forward as a test of machinability, as a test of soundness and as a test of tensile strength. The idea that a Brinell test should be employed to determine whether a casting can be machined is a little naïve, for it is necessary either to machine or at least to file the casting before the test can be applied. As a criterion of soundness in a casting the test is also unreliable, because the hardness varies considerably across the section of a casting, and any unsoundness usually occurs in the very part which it is impossible to test—the middle. This same lack of uniformity across the section of a casting makes the Brinell test unreliable as a measure of its tensile strength. The one purpose for which the Brinell test is valuable is as a test of uniformity among castings from a single simple pattern produced at different times, different foundries or under different conditions.

The Transverse Test.

The transverse test is by far the most commonly-used test for cast iron, and at the same time it is probably the least understood. In operation the test is simplicity itself. A bar is supported at both ends and subjected to a transverse load midway between the supports. The breaking load is measured, and also, as a rule, the deflection. The result of the test is often quoted simply as the maximum load. For bars of identical dimensions this is satisfactory, but for more general comparison it is better to compute the apparent maximum stress in tons per square inch, using the ordinary bending formula. This apparent stress is called the "modulus of rupture," and is found to be much higher—usually 60 to 100 per cent. higher—than the tensile strength of the iron as measured in the ordinary way.

The reason for this wide discrepancy has never been explained. It is known that the value of the modulus of rupture depends on a number of factors besides merely the tensile strength of the bar. It depends on the variable strength and brittleness of the metal at different points across the section, and upon the distribution of stress, which is not by any means as simple as the ordinary theory suggests. It is known that short bars appear stronger than long ones, that big bars give lower values than small ones and that a bar of circular section is some 20 per cent. stronger than a square one, irrespective of the shape of the bar when cast. On account of these variations it is necessary to standardise the dimensions of test-bars rather closely if the results are to be compared with any confidence. One drawback to the transverse test which is not commonly realised is the fact that, although the bar may contain 20 lbs. of metal or more, yet it is virtually only tested across a single section: that directly under the load. A small flaw at this point will, therefore, influence the result seriously, while any number of flaws elsewhere will probably pass unnoticed.

In spite of these imperfections and of the difficulty of interpretation, the transverse test stands out as a simple and ready index of some combination of useful mechanical properties, though it is of little use as a criterion of soundness in the bar and still less as a criterion of soundness in the castings. Until recently the commonest transverse test-bar in this country was 1 in. square, tested over a length of 12 in., though sometimes a 2-in. by 1-in. bar was used, tested over a 36-in. span, or occasionally over a 12-in. span. On the Continent and in America round bars have for a long time been the accepted standard.

It is well known that the 1-in. by 1-in. and 2-in. by 1-in. bars were not chosen according to the type or sizes of casting they were intended to represent, but according to the particular authority for whom the tests were carried out. In other words, if under the control of a single authority, rain-water goods and hydraulic rams might be tested by means of the same test-bar. Now it is a well-known fact that qualities of cast iron depend not only on the composition and temperature of the molten metal but also upon the conditions of cooling in the mould, and, therefore, on the mass and sectional dimensions of the casting.

The Mass Effect.

This mass effect is of great importance in cast iron, for it controls to a large extent all the mechanical properties of the iron in the casting, and, incidentally, may give very different results in different parts of the same casting. Since recent modifications in the standard methods of testing have been largely based on a recognition of the mass effect, it is desirable to form some idea of the changes it can produce.

This subject has been the subject of experimental investigation at the Bradford Technical College, and the results of this work will afford some indication at any rate of the differences which may be anticipated between castings of different sections cast from the same metal. The tests were made on bars cast in various diameters, from ½ in. to 3 in., in each case from the same ladle of metal. The bars were sub-

* A Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen, Mr. H. Sayers (Branch-President) presiding.

jected to tensile tests, compression tests and Brinell-hardness tests, and the results are shown in Figs. 1, 2, 3. From these it will be seen that the strength and hardness both fall away considerably as the diameter of bar increases, but that the changes vary from one type of metal to another, so that no general rule can be formulated to cover different metals. These results are not difficult to understand when the metallurgical constitution and structure of cast iron are taken into consideration, for the size and form of the graphite content of the iron varies enormously over the range of bars tested, being fine and mainly nodular in the small bars, but coarse and lamellar in the larger ones.

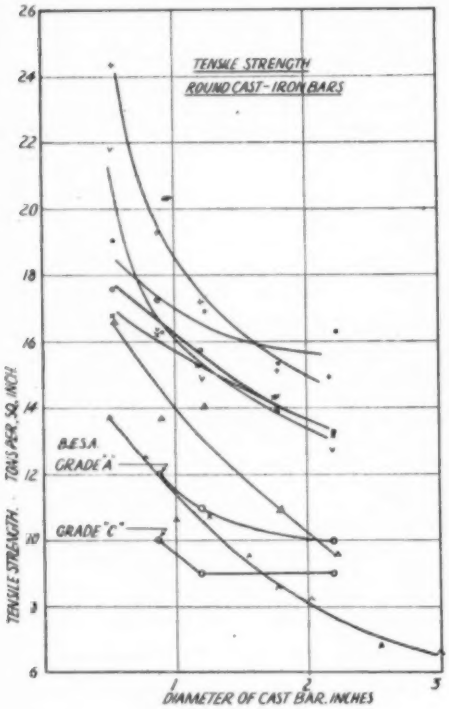


Fig. 1.

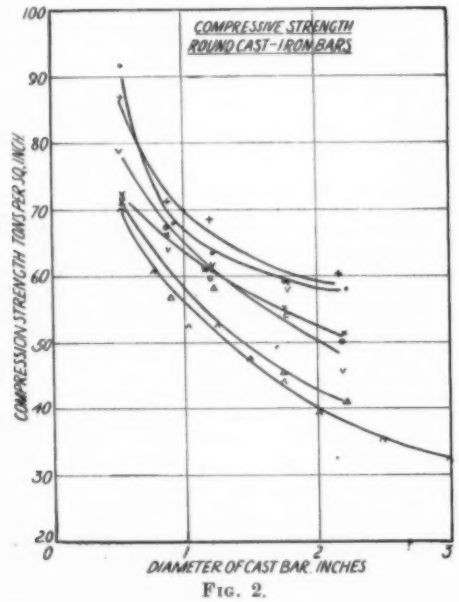


Fig. 2.

The B.E.S.A. Specification.

Recognition of the effect of mass on the mechanical properties of cast iron has formed the basis of the current B.E.S.A. specification for general grey iron, issued in February, 1928. The authorities responsible for this specification have realised that it is impossible for a single standard test-bar to be representative of every size of casting in the same metal, and they have classified castings into three groups according to their "main cross-sectional thickness." For each of the groups a different test-bar is specified, and a different standard of strength is required. The scheme of classification is tabulated in Table I, with the test requirements corresponding to each size of bar.

Table I.—*B.E.S.A. Specifications for Cast Iron.*

Key.	Thickness of casting.	Transverse bar.			Tensile test.		
		Cast dia.	Modulus of rupture.		Turned dia.	Tensile strength.	
			Grade A.	Grade C.		Grade A.	Grade C.
S	$<\frac{1}{4}$	0.875	24.2	19.6	0.564	12	10
M	$\frac{1}{4}-2$	1.20	23.1	18.9	0.798	11	9
L	>2	2.20	19.2	17.2	1.785	10	9

This specification must be regarded as representing authoritative British opinion on the subject of cast-iron testing at the present time. It is, therefore, a document of no small importance. It must be remembered that a specification such as this is not only bound to influence manufacturing practice and standards in this country, but is also important as a broadcast manifesto by which other industrial countries are invited to judge our technical standing and progress. Any standard specification should therefore be prepared to face criticism as a technical document, and should be as perfect from the technical standpoint as is possible in the existing state of knowledge.

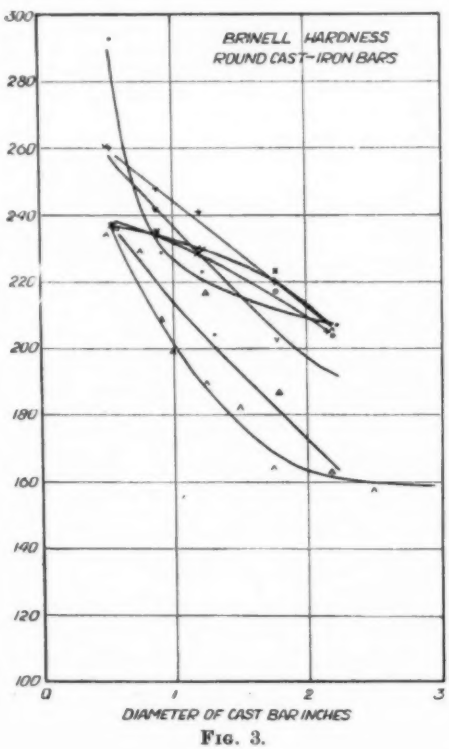


Fig. 3.

The present specification therefore demands careful study and attention from all concerned for the future of British ironfounding and engineering. If it is technically sound and fair in its demands, then it is incumbent on all foundrymen as well as testing authorities to encourage its general adoption. If, on the other hand, it has weaknesses which are destroying confidence in it, then it is their duty not to allow the whole specification to become a dead letter in favour of methods already a century old, but to amend it into something which can be adopted with confidence—and then to see that it is adopted. Since there is reason to suppose that this specification has not received the attention it demands, it will be well to examine it in some detail from the technical point of view and to inquire whether or not it is adequate for its intended purpose, which is to provide a safe criterion of the strength of grey-iron castings.

In its main principles the B.E.S.A. specification is undoubtedly an improvement over the older methods of testing. First and foremost, of course, it makes explicit allowance for the different sizes of castings, which, as already demonstrated, is a matter of the first importance and marks a definite advance in testing technique. The other important change is the adoption of a round test-bar in place of one of square or rectangular section. The effect of this change on the results of transverse tests is illustrated in Table II. The tests referred to were carried out on bars cast from the same ladle of metal by Messrs. Hill Brothers, of Leeds, and each figure represents the average of three tests. These results confirm substantially those obtained by other workers with different classes of iron, and show that with exactly the same metal round bars give considerably higher transverse tests than bars of rectangular section. There is no technical reason against the general use of round bars, and since their adoption brings British procedure into line with Continental and American practice and removes the apparent disadvantage under which British tests have suffered in the past by comparison with others, the change is one which should be cordially welcomed by ironfounders. The supersession of the long 36-in. transverse bar by shorter ones is also a matter for satisfaction, for short bars always tend to give higher test results than long ones, and, moreover, since a transverse bar is really only tested across a single section, the shorter the bar the less metal is wasted.

Table II.—*Actual Working Results on Various Types of Test-Bars.*

Section.	Length.	Modulus of rupture.	Tensile.	Crushing.	Brinell.
2×1	36	23.9	—	—	—
2×1	12	27.4	—	—	—
1×1	12	26.2	—	—	—
		B.E.S.A.			
0.875	12	33.5 (24.2)	18.9	72.1	248
1.20	18	31.5 (23.1)	17.2	68.8	238
2.20	18	28.6 (19.2)	14.5	59.0	207

It is doubtful whether the insistence on a minimum deflection is altogether advisable in transverse tests on rather short bars. The measurement of this deflection to 0.01 in. is a matter of some uncertainty, and with the old 1-in. by 1-in. by 12-in. bars it has been found that measurements on different testing machines do not by any means always agree. Moreover, within the author's experience, test-bars which have broken short in the transverse test have invariably given a low modulus of rupture. However, there is no real cause for complaint in the deflections specified, from the foundry standpoint, for these are usually well exceeded by good bars.

Effect of Removing the Skin.

As regards the tensile tests which are carried out on the parts of the broken transverse bar,

there can be little objection to these as laid down in the specification. There has been a good deal of difference of opinion in the past regarding the effect on tensile strength of machining away the skin, but, as already mentioned, the effect of the result of the test is certainly not detrimental, provided the depth of machining is not abnormal. Indeed, for the small and medium sizes of bar it is unlikely that any considerable difference will be found however far the bar is machined. In any event, the specification is free from objection on this ground, and will give fair comparative results, because it standardises the diameter both of the cast bar and of the turned bar.

On main principles, then, there is little fault to be found with the new specification. But when it is examined in greater detail, and to consider its application in practice, there are certain points on which it seems possible, and desirable, to effect improvements. It must be remembered throughout this discussion that the test-bar itself is only a means to an end. The ultimate purpose of the test is to ascertain, not whether the test-bar, but whether the castings it represents, are satisfactory for their purpose. There are, therefore, two needs to be fulfilled; the test must be a true test of the test-bar, and at the same time the test-bar must be a true sample of the metal in the castings. To this end it is necessary that the bar and the castings shall be cast under the same conditions and contain as far as possible metal of the same properties.

Separate and Cast-on Test-Bars.

Now the specification itself does not lay down a rule as to whether the test-bar shall be cast on to one of the castings or cast separately. Objection has been raised in some quarters to the practice of casting test-bars in separate moulds, and this procedure certainly lends itself to abuse as the specification stands, for, although it is wisely specified that "all test-bars shall be cast in green-sand or dry-sand moulds according as to whether the casting or castings they represent are moulded in green sand, or in loam or dry sand respectively," yet no ruling is given on the important matter of the head under which the bars are to be cast.

On the other hand, there is room for quite as much abuse if test-bars are cast-on unless careful consideration is given to the location of the test-bar relative to the main mould. The lower the position of the bar in the mould, and the further it is from the main mass of the casting, the higher are the test results likely to be. To give a comprehensive ruling on this point which would cover all cases of cast-on bars would be almost impossible, and it is therefore suggested that the most satisfactory solution would be to cast the test-bars separately in a specified way and under a specified head, or under the same head as the highest portion of the casting. Incidentally, this method would probably give least cause for dissatisfaction in the foundry.

In the next place, no ruling is given as regards the setting of the mould for the test-bar, or as regards the way in which the bar shall be set in the testing machine. Bars cast vertically, obliquely or horizontally will give different results under test, and different again according to the head under which each has been cast. A horizontal bar gives different results according as the cope side is set in tension or compression in the transverse machine, and a vertically-cast bar will give quite different results in the tensile test according as the tensile test-piece is taken from the upper or lower end of the bar as cast. These may be regarded as matters of detail, but they make a considerable difference to the results and would be liable to lead to dispute and abuse if not made clear in the specification.

But there remains a still more important matter to which it is necessary to draw attention, and that is the range of thicknesses of casting to which the three sizes of test-bar are to be applied. It will be remembered that the $\frac{7}{8}$-in. bar is intended to be representative of castings whose "main cross-sectional thickness" does not exceed $\frac{3}{4}$ in., the $1\frac{1}{4}$-in. bar of all castings between $\frac{3}{4}$ in. and 2 in. thick, and the 2.2-in. bar of all heavier castings. This must be taken to imply that the mechanical properties of a $\frac{7}{8}$-in. bar correspond to those of castings up to $\frac{3}{4}$ in. thick and the mechanical properties of a $1\frac{1}{4}$-in. bar to those of castings between $\frac{3}{4}$ in. and 2 in. thick. If this is not implied, then the whole purpose of the specification is defeated, for it then openly ignores the very mass effect on which it is ostensibly based.

It therefore becomes important to determine whether the mechanical properties of the three test-bars do in fact correspond to those of the specified thicknesses of casting. On general grounds this seems unlikely, for it would imply, for instance, that the properties of two castings $\frac{7}{8}$ in. and 2 in. thick would be so nearly identical as to be fairly represented by the same test-bar. But general arguments are notoriously unsafe, and direct comparative tests form the only safe ground for judgment.

Comparative Tests on Cast Plates.

To obtain reliable information on this point, a number of comparative tests have been made in the Bradford Technical College on round and flat plates cast in different diameters and thicknesses, each lot being cast in the same way and from the same metal. In order to make this scheme of testing a success and the results representative, it has been necessary to secure the co-operation of a number of different foundries, and this co-operation has been secured largely through the kindly help of the late Mr. Poole, of the Keighley Laboratories. For the moment the author does not feel at liberty to reveal the identity of all the foundries concerned, so his acknowledgments to them must be quite general, but they are none the less sincere.

In carrying out these comparative tests it is assumed that the "main cross-sectional thickness" of a casting is fairly represented by a plate of the same thickness. Whether or not this is true depends, of course, on the shape of the casting. For castings approximating to the plate, box or cored cylindrical type, the assumption is clearly unjustified, but castings which themselves mainly consist of bar sections would obviously correspond to bars of approximately the same sectional area as the bar units in the castings. The large majority of castings in general foundry practice are of the "plate," as opposed to the "bar," type; and it is for these that the specification is mainly required, and for which the present series of tests were undertaken.

In this series of tests it was not considered satisfactory to attempt a comparison of the round bars with the plates on the basis of transverse tests, so the comparisons were made in tensile strength, compressive strength and hardness. Each set consisted of five round bars, from $\frac{1}{2}$ in. to 2.2 in. diameter, including the three B.E.S.A. bars, and five plates from $\frac{1}{4}$ in. to 2 in. thick.

For comparative purposes among themselves, the round bars were subjected to a transverse test before turning down for tensile and other tests. The results are plotted in Fig. 4, and they show that the general standard of reputable foundries, particularly with the smaller bars, is distinctly higher than the requirements of the B.E.S.A. specification. The falling away in the modulus of rupture with the bigger bars is in accordance with expectations, and with the falling away in the other forms of test to be referred to later. One iron shows remarkably little drop in transverse strength with the bigger bars, and a modulus of rupture of 30 tons per sq. in. for a 2-in. bar must surely challenge comparison with even the best proprietary irons being cast to-day.

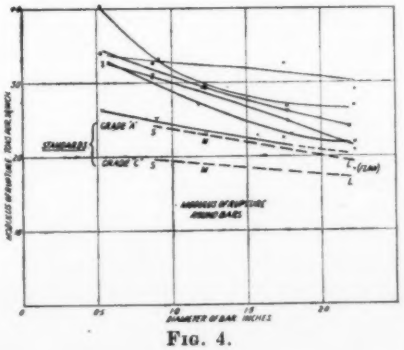


Fig. 4.

To give a complete comparison of all the tensile, crushing and hardness tests would occupy too much space, but the results from three different irons are shown in Figs. 5, 6 and 7. Each figure refers to one iron only, but covers all three forms of test on all sizes of bar and plate. Figs. 5 and 6 may be taken as typical

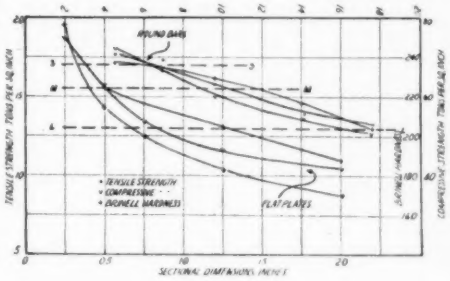


Fig. 5.

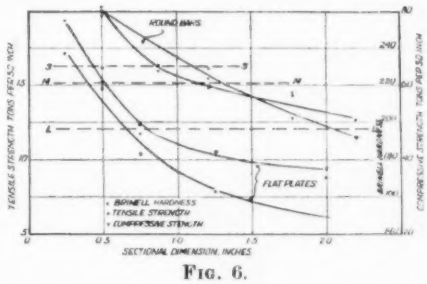


Fig. 6.

of the bulk of the tests. It will be noticed that in all cases the test on a bar, cast round, is considerably higher than that on a plate of equal thickness. Lines drawn through the points corresponding to the small, medium and large standard bars show that the thicknesses of flat plate to which these correspond are in each case approximately one-half the diameter of the bar. Thus it will be seen that the $\frac{7}{8}$-in. bar corresponds to a plate casting about $\frac{3}{8}$ to $\frac{1}{2}$ in. thick, the 1.2-in. bar to one $\frac{5}{8}$ to $\frac{3}{4}$ in. thick and the 2.2-in. bar to a casting about 1 to $1\frac{1}{4}$ in. thick.

Fig. 7 refers to the rather exceptional iron to which attention has already been drawn. In

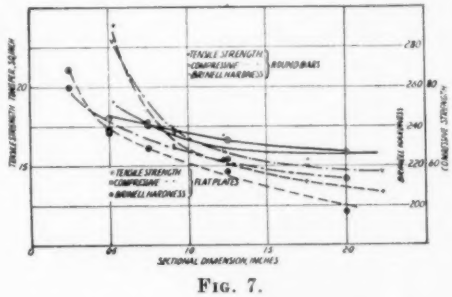


Fig. 7.

this case the changes in mechanical strength are comparatively small with different bars and plates, as was foreshadowed by the transverse results, and the mass effect has been reduced to a minimum. Consequently the iron is comparatively indifferent to the particular size of test-bar chosen, and the standard laid down would serve reasonably well. But this is admittedly

an exceptional iron, and rules for general practice should not be based on exceptions.

B.E.S.A. Standard Bars Not Truly Representative.

Taking into account the results with all the seven irons so far tested, it would appear that for the types of cast iron encountered in ordinary practice the B.E.S.A. standard bars are not truly representative of the ranges of thickness laid down in the specification. It may be that there are other potent reasons underlying the choice of these bars or ranges, and in that case it is very desirable that they should be made clear. But as it stands at present, the specification appears either to be based on incorrect premises in this matter or to be misleading as to its intentions.

Regarding the problem from the standpoint of the disinterested observer, whose chief concern is that a test should be as truly representative as possible, the author would venture to make a suggestion. It would clearly be a troublesome and difficult matter to alter the three sizes of specified test-bars, for this would involve a reconsideration of all the test requirements in the specification. But it would not be at all a difficult matter to modify the ranges of thickness to which these bars refer so as to bring them more closely into agreement with proved facts and the results of common experience.

The simplest reasonable classification which seems to accommodate the present bars is that shown in Table III. Here the majority of cast-

Table III.—*Suggested Range of Thicknesses to be associated with the B.E.S.A. Specification.*

Test-bar.		Range of thickness represented.		
Symbol.	Diameter in.	B.E.S.A.	Suggested.	
			Plate.	Bar.
S	0.875	$\leqslant\frac{1}{2}$	$\leqslant\frac{1}{2}$	$\leqslant 1$
M	1.20	$\leqslant 2$	$\leqslant 1$	$\leqslant 2$
L	2.20	> 2	$\leqslant 1\frac{1}{2}$	$\leqslant 3$

ings will be covered under the category of plate castings, and the suggested ranges of thickness are considerably lower than those contained in the specification. For plate castings over 1½ in. thick it would be impracticable to produce or test a representative transverse test-bar. Under these circumstances the most rational method of testing would be to cast a round bar twice the thickness of the plate casting, and from this to obtain tensile and compression specimens. These two tests, together with Brinell tests at different points across the section of the bar, should give reliable information as to the real strength of the casting. It would, of course, be necessary to fix a graded scale of standard strengths for such cases, based on tests made specially for the purpose. This method of testing for large castings would admittedly involve more trouble than the B.E.S.A. method, but the castings to which it would be applied would be sufficiently important and costly themselves to justify the small additional expense.

As regards castings of the bar type, the suggestions made in the last column of Table III are based on the principle that the sectional area of the test-bar should be approximately the same as that of the bar unit of the castings. A number of types of casting must, of course, pass through the foundry from time to time which do not obviously fall into either the plate or bar categories, or whose "main cross-sectional thickness," for one reason or another, is a matter of uncertainty. In such cases it is suggested that it should be open to the engineer or purchaser to specify, at the time of inquiry, the particular bar on which he requires the tests to be carried out.

The author does not anticipate that his suggestions will meet with approval by all concerned; indeed, he hardly dares to hope they might. The main purpose in composing this subject is to arouse something of a controversial interest in the principles of cast-iron testing, as he feels that only by stimulating a keen general interest will it be possible to convert the B.E.S.A. specification from the dead letter which it is in danger of becoming at present into an effective weapon for the advancement of British ironfounding.

DISCUSSION.

The Branch-President (Mr. H. Sayers) said they had listened to an extremely lucid lecture on a very confused subject. Dr. Swift had given them much controversial material. Personally, he found a ¾-in. bar useless, as it was altogether too sensitive. The 1.2-in. bar was, in his view, the smallest that should be used. The whole trend of testing seemed to be in the direction of more expense. He (Mr. Sayers) should like to know whether, in referring to the machining effect, Dr. Swift thought that mechanical work done on the tensile bar had not some effect in improving the strength.

Machining Effect.

Mr. A. S. Worcester (Huddersfield) said Dr. Swift had proved his case up to the hilt. He had, however, rather surprised them by saying that he found the bars better with the skin off than with the skin on. But he had proved it. With tooling there was a sort of grinding action or rubbing action, which left a much more regular outside than on the rough casting. They would all agree with Dr. Swift as to the strength of the iron being nearly always due to the formation of the graphite rather than the actual amount of it. Trouble was always possible owing to the fact that smelters were running the blast furnaces at a higher temperature. Where there was the same analysis from the hotter furnaces, they were not getting the same strength that they got with the colder blast. They had been one of the last nations to get standardised tests, but a point was that the English iron was stronger than the Continental and the American iron, and these specifications that they had got now were really lower than the Englishman would like, but they knew they were in competition and therefore had to put up a standard which would be acceptable to other nations. Mr. Worcester thought the tests now in force were much better than the older ones, which he personally would have liked to be higher. The position of the bar on the casting was a very important point. Another factor was the matter of the strength of the lower portion being due to the compression of the hot metal. Whilst the 2.2-in. bars did not give actually the strength of the casting, it certainly did give the standard from which one could work.

Founders' Attitude in the Past.

Mr. S. W. Wise (hon. secretary) said Dr. Swift had covered much of the ground which was familiar to them, but had also given them the results of his own experience in connection with cast-iron research. The matter of testing bars had been a vexed one so long as the oldest of them could remember. No one had ever thought that the test-bars were worth the trouble expended upon them. For years founders had been making test-bars and having to put them on castings under such conditions that they knew they were no indication of the strength of the castings. Certain physical results were demanded by users of castings, and at the same time the users had asked that the material should be of such chemical constitution that practically contradicted the results that they had legislated for. The Test Bar Committee of the Institute had sat now for several years. Other committees innumerable had been formed to search the ground thoroughly and then issue B.E.S.A. specification which approximated nearer to good results than any previous efforts. But suppose they had a test-bar with a casting and then an inspector, with a wide engineering experience, came along. Was it his duty to accept that test-bar in view of the conditions under which the casting had been made?

The general output of the foundry and the reputation of the foundry, thought Mr. Wise, should be a much better criterion than the odd test-bar with the casting. There was not, he would suggest, a foundryman present who could repeat his test-bars twice. The variations might not be great, but they would increase with the section of the casting for which he was using his iron. He (Mr. Wise) hoped that Dr. Swift's views would be ventilated right through the industry. The Technical Committee of the Institute would be only too glad to avail themselves of these test experiments to add a little enlightenment to the questions which had vexed founders for many years past.

AUTHOR'S REPLY.

Dr. Swift, replying, said, in answer to the chairman's question, he thought it was possible that the work done in the actual process of turning might have some effect of improving the tensile strength, but another test was the test of the intrinsic qualities of the metal. As to Mr. Worcester's point about keeping down the standards in order to compete with other nations, Dr. Swift said he had not really been intending to argue that the British standards were low, but he had a feeling that when a foreigner got hold of the specification he would think that that was the standard type of tensile strength of the iron which we were using in this country to-day. They knew perfectly well, by the published results of the American foundry trade, that the results obtained by tests in this country, illustrated in the diagrams, would compare very favourably with the iron which they had produced in America except in cases of special mixtures. Mr. Worcester had pointed out that although the 2.2-in. bars, for example, might not actually correspond to parallel bars with the metal only 2- or 3-in. thick casting, it gave a standard whereby two irons could be tested. That was mainly true, he thought. Certain irons fell away in strength much more rapidly than others did. It did not follow that the bar which was going to give the best test at 1 in. was necessarily going to be stronger when it was cast 2 in. thick. That was illustrated by the results. It was only fair that an iron of that kind should receive proper recognition. He thought they should aim at producing a test-bar which should be representative of the casting because the designer was liable to base his designs on the test. Mr. Worcester had said he thought that his (Dr. Swift's) address might be given wider publicity. But as a matter of fact the work was still going on. Through the kindness of various founders they were being enabled to test more, and if they found that the results were still definitely sustained he did not see why they should not be prepared to stand by them on a wider platform than that of that evening. Mr. Wise (went on the speaker) had questioned whether it was fair or desirable to judge the attitude of a founder upon just one test or another. Mr. Wise was right in a general way. He (Dr. Swift) was not at all a chemist or a metallurgist. He liked to call himself an engineer. But he had distinctly the feeling that the competent metallurgist, with a microscope, could tell him more surely whether a particular iron was suitable for a certain purpose than anyone who simply carried out a mechanical or other test. He had great confidence in the power of the microscope so far as iron was concerned. But they would never get inspectors who would have that power of discriminating between sound and unsound iron under the microscope, and they would never get inspectors who would accept anything else than figures. The question of the variations between two ladles was, as Mr. Wise had said, a matter of considerable importance, and that was the reason why these tests had to be carried out under identical conditions. Dr. Swift said he wished to express his appreciation of the work which Mr. Nichols had put in in connection with the tests. The kindness which

(*Concluded on page* 280.)

Some Developments in Modern Foundry Practice.

By E. Longden.

(*Concluded from page 262.*)

CORE- AND MOULD-DRYING PLANT.

The modern system of mould and core drying has done much to improve the atmosphere of the foundry. Also fuel economy has been secured with an increase in productivity per cubic foot of stove area. The Plenum system is one of the most successful methods of drying. The principle of the system is to admit primary air to a firebox and burn fuel to give a considerable temperature and heat, and then to admit a further supply of secondary air to temper down the heat just before passing into the stove from the separate firebox. Large volumes of hot gases thus formed are driven through all parts of the stove at the necessary velocity to carry away moisture. The constant replacement of the moisture-laden gases in the stoves allows full use to be made of the heat generated before it passes away to the outlets and chimney. It will be obvious that it is possible to control and determine the output of the stoves to within very near limits.

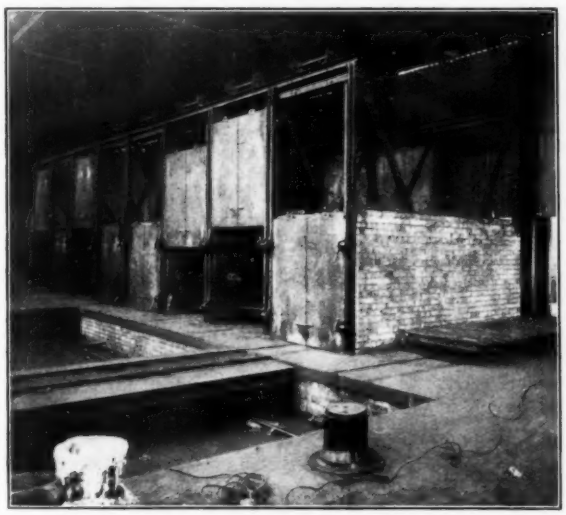


Fig. 11.—Drying Stoves.

Fig. 11 pictures a section of a battery of sixteen stoves fired from two underground fireboxes. This photograph also shows a transfer arrangement to facilitate the withdrawal of carriages and loading of stoves, thereby eliminating congestion. The loaded carriages can be passed from the back of the stove on to the transfer bogie noted in the foreground of the photograph and back again to the casting bay. Floor moulds are most effectively dried in position with portable driers. Fig. 12 shows two such driers located on the top part of a large bedplate mould. Hot gases are generated on the same principle as before mentioned for the stoves and driven through the mould below. Vent outlets are provided for the free exit of gases saturated with moisture from the drying mould face.

PROGRESS IN JOBBING FOUNDRIES.

Improvement in the jobbing and semi-jobbing foundry has been accelerated by adopting many of the devices which form part of the general equipment for continuous-casting plants. The provision of a central sand-mixing department where all sand is conditioned is now being adopted. The backing sand can be delivered from various points in the foundry by underground conveyor belt to the sand-mixing plant, or moulding boxes with the contained sand may be delivered to a mechanical or hand knock-out station adjacent to the sand-mixing plant. The prepared sand can be delivered by distributing conveyor belts to various points and fed into hoppers above the moulding station. The ramming of the moulds may then be carried out by hand, plain jolt ram or used directly through a sand-slinger machine, as may be deemed practicable. Fig. 13 shows the use of Herman power-moulding machines and a Pneulec Bartlett-Snow sand-handling system applied to a semi-jobbing foundry in Franklin, U.S.A.

Fig. 12.—Drying a Large Mould by Modern Portable Dryers.

In small or large foundries the mechanical grab is being more extensively used for distributing sands and unloading materials from conveyances. The grab can also be of great service in excavating moulding pits either in preparation for moulding, or after the casting has been extracted to lift out the sand and *débris* and in conveying these materials to a central sand-mixing department, or to a near-by point to be mixed and sorted by hand. Other modern methods of transporting materials are by hand-operated or man-riding mono-rail systems, and electric and gasolene trucks operating ordinary or tip-up containers. Electro-magnets are now used in many foundries to handle metal and also for use with the scrap break-ball. Plain and turnover jolt machines are now fairly widely used and the sand-slinger has proved very effective in ramming moulds of any type. The machine is constructed to serve a variety of conditions in both jobbing and repetition foundries. On the Continent and abroad much greater use is made of pneumatic rammers than in Britain.

Skilled Moulders.

Whilst it is admitted that there is a grave shortage of really highly-skilled moulders, there are to-day among the diminishing numbers some very accomplished and technically-trained craftsmen. The production of this type of craftsman is becoming more possible due to the excellent facilities for general and vocational education and training. It is very difficult to refer adequately to the improvement in craftsmanship in the confines of such a Paper. However, the following account of the production of a large casting will serve to show the need for improved craftsmanship in spite of the simplification of the methods of production. The system outlined envisages the reduction of immediate and future pattern-making charges by the provision of a pattern segment instead of a full pattern and

Fig. 13.—View in a Semi-Mechanised Jobbing Foundry.

of moulding costs by quicker and simpler moulding and the standardisation of moulding boxes. Such equipment can be used for various types of castings.

Moulding a 20-Ton Hydraulic Cylinder Casting.

The pattern consists of a wood segment I (Fig. 14) about 3 ft. 5 in. deep, of the required diameter, and loose pieces to form the ribs, flanges and sink head, etc., and located on a machined cast-iron plate J. A cross-section of sections of moulds made from the segment pattern. To do this, moulding boxes L (Fig. 14) are located around the pattern segment I on the machined cast-iron plate J, gate sticks located and ramming carried out by jolt-ram machine or by hand. In either case the mould must be rammed very hard and sound to prevent burning-on, scabbing and penetration by the molten metal, especially towards the bottom end of the mould as cast, as this end is subject to the heavy

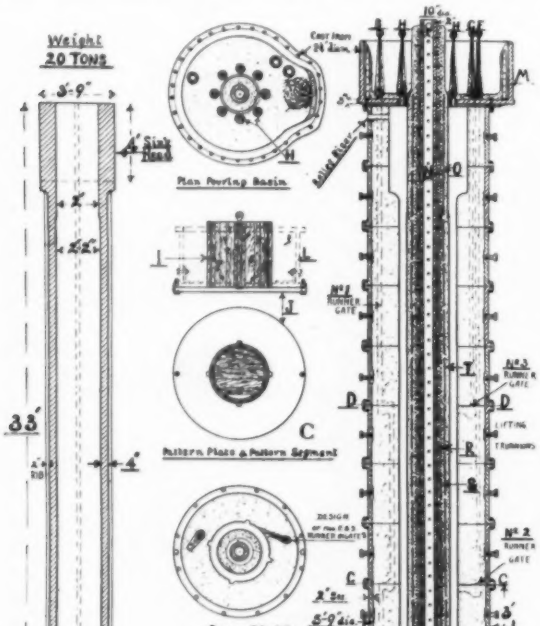


Fig. 14.—Cross-Sections of Hydraulic Cylinder Casting A and Mould B.

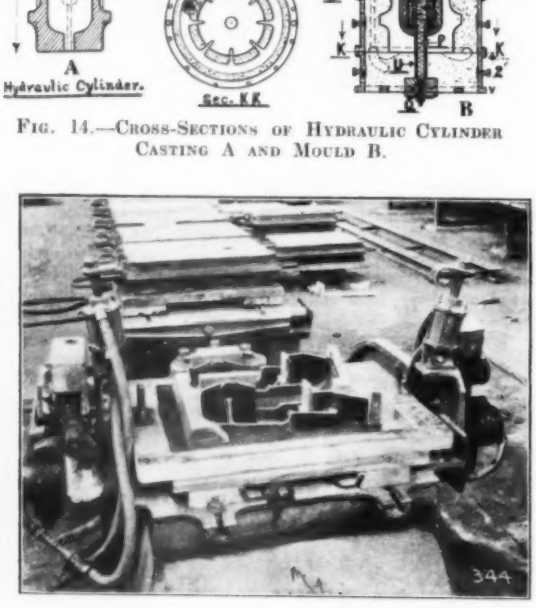


Fig. 15.—Jar-rollover Moulding Machine.

The 10-in. diameter barrel N to carry the core O is of very strong construction, being made of cast iron with a full 2-in. section and is perforated to allow free drying and venting. The bottom end of the barrel is machined on the inside for about 18 in. to allow the fitting in of the steel bar P which carries the small diameter of the core U (6 in.) and provides for a means of securing the core by bolting down, as shown at Q. The core is made by placing the barrel

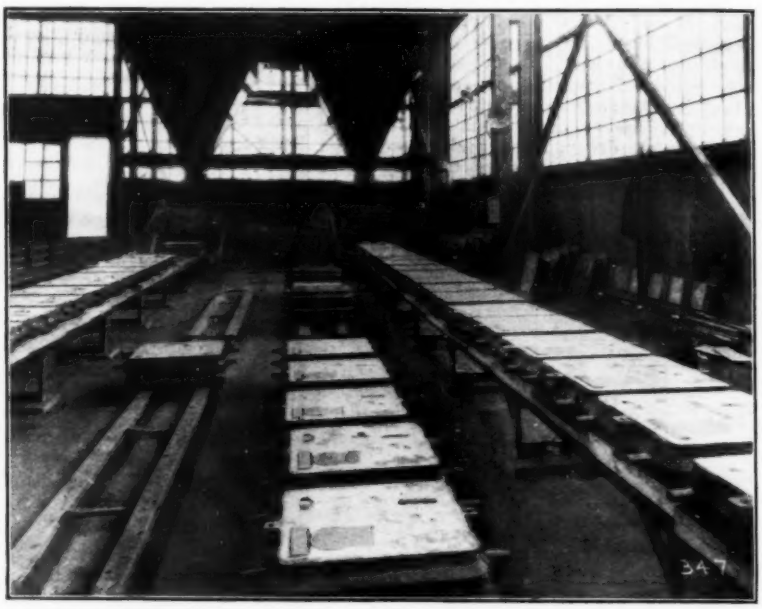


Fig. 16.—Producing Castings of a Semi-Repetition Nature.

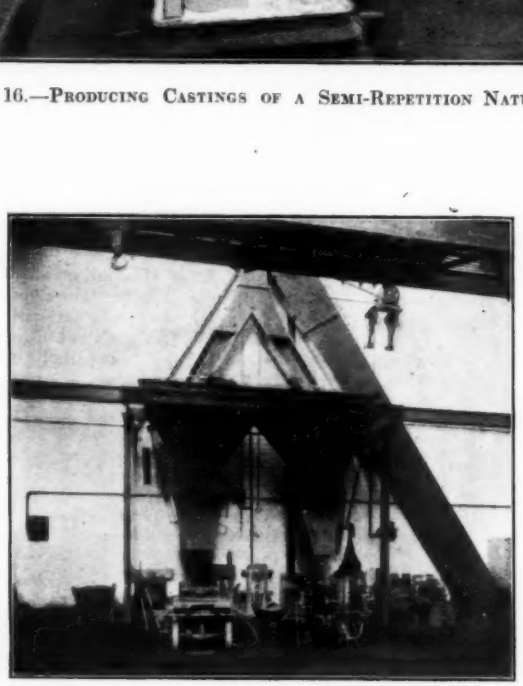


Fig. 17.—Sand-Delivery Plant in the Foundry of Messrs. S. Russell & Sons, Leicester.

the casting with header—total weight 20 tons—is shown at A, Fig. 14. The cross-sectional view of the mould shows that 13 sections are needed to complete the length required for the casting, including the pouring basin as shown at A. Moulding of the sections proceeds in the order of drying requirements and the building of the complete mould, and starts with the bottom section KK.

Moulding, therefore, proceeds by ramming up pressure in addition to impact and temperature of the molten iron. Special refractory composition sand is used to face the mould. The pouring basin M is arranged to close in the top side of the mould around the core, to allow for the scheme of runner gates and to carry a very substantial reservoir of metal. This part of the mould is made of brick and loam and very strongly constructed to withstand the large amount and heavy flow of metal.

horizontally on four cast-iron trestles spaced to support the core and prevent bending. The core is then built up to the wooden sweep board. Wood pegs, $\frac{3}{4}$ in. diameter, are fastened in a number of the vent holes to prevent a movement of the swept-up material. Two layers of straw rope S are carefully built on the barrel so that the strands do not touch, leaving space for about 1 in. of loam material to prevent crushing of the core. Iron rods T are next spaced in a wet-

loam setting and well wired together, and the final coats of loam applied. Strict attention must be paid to the drying of the core, as any dampness will lead to disaster. To ensure thorough drying, the core is passed into the stove after each layer of loam has been added—in all, about five times.

The construction of the core as outlined is designed to give the great strength needed to resist the tremendous pressure and pounding of the molten metal during pouring, and, at the same time, to be free venting and allow for the extraction of the core after cooling—and this is no mean task under the best of conditions. The assembling of the mould starts with the seating down of the bottom box on solid cast-iron bearers raised high enough in the casting pit to allow of sealing and fastening the core. After two further box sections have been located and well bolted together, the core is lowered into the two box sections and down into the 6-in. core print U. The core is centred and maintained in such a position by passing temporary wooden chaplets through holes in the moulding-box sides as indicated at D. These wooden chaplets are withdrawn when the mould is completely closed. When all the sections are located, with the exception of the pouring basin and top plate M, the core is sealed around the bottom print U, and secured by bolting through the mould with the aid of the steel bar P, as at Q. The mould is then solidly rammed around by floor sand past the fourth joint to prevent any break-away of metal where the pressure is greatest.

When casting, the metal first flows into the pouring basin M, and, when a good reservoir of metal is contained therein, a ball stopper B is lifted, allowing metal to pass through No. 1 runner gate, down which it falls to the joints CC and DD, where the stream of metal is broken to prevent a too heavy impact of the falling metal on the bottom face of the ingate and mould. When it is judged that sufficient metal has been admitted through No. 1 runner and fountain gates E to have risen above the section CC, No. 2 runner-gate ball stopper F is lifted and metal admitted at an tangent and, again, when metal passes section DD, No. 3 runner gate is opened by lifting stopper G, and, finally, about seven or eight tons of metal is allowed to enter through the series of top-drop gates shown in the plan of the pouring basin at H. These top-drop gates break up the rising scum and tend to float it into the header. A relief riser is located about 6 in. from the top of the sink head and serves to check the effect of the quickly-rising metal. After the flow-off has ceased the hole is plugged up and the head filled with hot metal and further metal is added from time to time.

CONTINUOUS-CASTING PLANTS.

It will be necessary, first of all, to describe generally the complete continuous-casting plant. Starting with the warm sand which has been shaken out of the moulding box by hand, pneumatic vibrator, or jarring device, over a knock-out grating on the floor level alongside a continuous-mould conveyor, sand falls into an underground hopper directing the material on to an inclined conveyor belt which carries the material to a revolving or vibrating screen where lumps of sand are broken up and pieces of metal—sprues, sprigs, gaggers—that may have fallen through the knock-out grating are separated and passed down a shute to a container. From the screen, the fluffed-up sand falls through to a magnetic separator extracting any small particles of iron which may have passed the mesh of the screen. From the separator the sand drops on to an inclined tempering belt on which the material is automatically wetted with water to which a little fire-clay bond may have been added, and new sand is introduced in measured quantity from an overhead stock bin. At this point the sand passes into a conditioning machine which blends, tempers and aerates the sand; the material is then in a fit condition to be used for the production of moulds.

The sand is next carried by an inclined conveyor belt to fall into the boot of an elevator which lifts the sand into an overhead storage hopper. The container may have a capacity to allow of a reasonable seasoning of the sand. The material is delivered from the bottom of the bin, aided by special feeder mechanism, on to a flat belt which distributes the sand to bins above the moulding station, the material being directed into these bins by suitably arranged ploughs. A measured, or controlled, quantity of sand is allowed to fall into the moulding box or snap flask, resting around the pattern on a power-moulding machine. The consolidation of the mould is accomplished by jolt ram, or squeeze, or both at the same time. Pattern withdrawal is carried out by operating the machine, first of all, to turn the moulding box over and extract the pattern aided by a vibrator; or the pattern can be withdrawn downwards, the moulding box or flask remaining stationary on the machine; or again, the moulding box may be engaged by pins which push the mould upwards from the pattern. Usually one moulder makes the bottom-half and another the top-half mould, both being suitably located alongside a mould conveyor. The machine moulder makes the bottom portion of the mould and places it on the moving conveyor. If the mould requires cores the setting is done at a core station, to which point the cores may have been delivered by overhead carrier belt. After coring and passing down the line, the top-half mould is placed over the bottom half at another station and at another point the mould is secured to withstand the pressure of metal. The pouring station is next reached and metal may be poured into shanks and ladles from a man-riding mono-rail crane, or the metal may have been delivered in a ladle adjacent to the pouring station by a hand-push mono-rail system and from which ladle small hand shanks are fed. Whilst pouring, the operator may stand on an escalator platform propelled at the same rate as the mould conveyor.

After pouring, the moulds pass along over a cooling run, and possibly through a cooling hood, in which air is blown on to the boxes to accelerate cooling. A further point is reached where the moulds arrive at the knock-out station, where the sand and casting is shaken from the box as previously stated. At this point the castings may be passed on to a conveyor, which carries them to a continuous-tumbling barrel, or diverted to an alternative method of cleaning the castings if they are not suitable for tumbling. From the tumbling barrel the castings are again fed on to a conveyor belt, from which they are directed into bins standing at the fettling or grinding stations. After dressing, the castings can be inspected and passed to stores, machine shop or despatch point, again by conveyor belts.

Another continuous system can operate as follows:—A foundry may have an apron conveyor running down the centre of the foundry a little below floor level. Moulds are made on power-moulding machines and placed on gravity roller conveyors located at right angles to the large central apron conveyor. The moulds are poured on the roller conveyor. After a period of cooling the sand and castings are knocked out of the moulding box on to the large apron conveyor, and the flasks returned to the moulding station by another roller conveyor running parallel with the completed mould conveyor. The sand and castings ride together on the central conveyor until a jigging or shaking grid is reached, which separates the sand from the castings, the latter being impelled forward on to a conveyor, which carries the castings to the dressing department. Another foundry may operate a system whereby a series of large turn-tables are linked up to serve the various operations. The sand-handling and delivery plant mentioned in the first general continuous plant can be modified to suit the last two systems mentioned above.

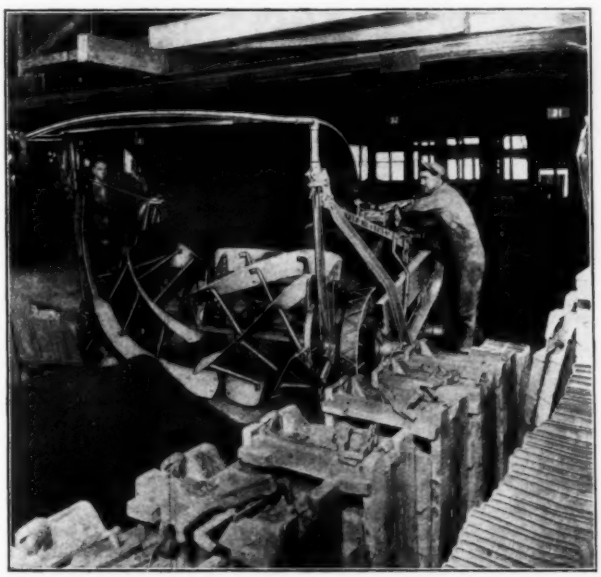


Fig. 18.—Sand-Cutting Machine.

Core Making.

Cores are made with some of the same facilities for moulds. Continuous-drying ovens are commonly used. As with the production of moulds, the making of cores can be split up into many specialised operations. A most noteworthy core-making machine for producing small cores may here be mentioned. Oil sand is impelled by pneumatic pressure from a container through a flexible tube placed to an opening in the closed core box. The effect is to produce a remarkably compact core almost instantly. Nor does it prevent irons being placed in the core. Such irons are placed in the open box and the incoming sand has the effect of lifting the core iron from the face of the core box and it becomes embedded in the body of the core. In many foundries making from light to heavy castings, sand-slinger machines are used for core-making as well as for moulds. In the River Rouge Ford foundry and others many sand slingers of a modified type are used. In one case noted, oil sand was delivered by an overhead conveyor belt to a small sand slinger comprised of a short arm and impeller head.

In the Willys-Overland Foundry, U.S.A.,

several casting units are operated to produce moulds and cores by sand slingers of a restricted type. Also, the extensive sand-handling system enables them to serve, in addition to ordinary general purposes, eight sand slingers, four on cylinders and four on crank cases. Figs. 15 and 16 show photographs of a pair of Pneulec-Herman 1,500 lbs. capacity jar-rollover machines with sand-handling and conveying equipment. The moulding machine is seen with a pattern mounted for a new line of castings and different from those which the moulds seen in the photographs will hold. In this same photograph will be noted small pieces of gravity roller conveyor on the sides of the pattern draw cylinder which are set at a slight angle so that the mould runs off automatically on to the main-line conveyor. One machine makes tops and the other bottoms.

Fig. 16 shows the general arrangement. Moulds can be seen sitting on rails set between the main lines of roller conveyors. It is on these rails that the moulds are closed, and then the crane comes along and lifts the rails and load, and so carries away a number of moulds at one time, setting them down in the pouring position in the foundry. The moulding boxes are run on gravity roller conveyors to the back of the moulding machines. Sand is conveyed by overhead conveyors to the large stock bins seen in the background of the picture. Note the sand shutes above the moulders' heads. Fig. 17 shows a photograph of the practical and comparatively simple application of a modified sand-delivery system, which resulted in considerable economy. This arrangement has been made in the foundry of S. Russell & Sons, Leicester.

Sand-Cutting Machines.

Many foundries operating in U.S.A. with only partial-continuous schemes which do not incorporate a sand-mixing and conditioning plant as previously outlined use a special type of machine —the sand-cutting machine—for mixing the bulk backing sand. The machines are supplied in a variety of sizes and can be built to be either man-riding or otherwise, and driven by petrol or electricity. Travelling speeds of 30, 60 or 90 ft. per minute can be obtained. Fig. 18 shows the machine operating effectively in the foundry.

Dressing Castings.

More recent improvements in the dressing of castings are by combined rumbler and sand-blast, pneumatic chippers, electric grinding machines and abroad, hydraulic cleaning of castings. The author was impressed with the possibilities of cleaning castings by water power in the works of the Baldwin Locomotive Company, Philadelphia, where they clean two-ton locomotive cylinders of all cores and adhering matter in about seven minutes, leaving only chipping to be done.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for February, report that although pig-iron production fell from 337,200 tons in January to 318,200 tons in February, the daily rate of output in the latter month showed an increase of 5 per cent.; unfortunately the number of furnaces blowing declined by 2 during the month to 81, or exactly half the number in operation at the end of February, 1930. Steel production, which to some extent had been affected by New Year holidays in Scotland in January, rose from 402,200 tons in January to 486,400 tons in February.

According to returns from 142 firms employing 84,298 workpeople the average weekly earnings per head in January amounted to £2 13s. 1d., compared with £2 12s. in December and £2 14s. 8d. in November. The returns received from 126 firms employing 62,521 workpeople in February showed an increase of 1,897 compared with January, and a decrease of 24,270 compared with February, 1930.

Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page 247.*)

No. 2. ADVERTISEMENTS—(*concluded*).

The advertisement writer should, having conducted a personal inquiry concerning the product, carefully note down all the possible ideas for advertisements that as a result occur to him. But he should not at once rush into print. His own judgment is not always adequate to decide upon their value. Before writing advertisements embodying them he should, therefore, watch their effect upon the manufacturer, the salesman, the dealer and a potential consumer, and act upon the result. He will soon be able to see which ideas are the most effective and most likely to sell the goods. His reward for all this perseverance and effort will come when he hits upon the big idea that will make the product famous, and that will give him an enviable reputation as an advertisement writer who counts.

The Manufacturer's Ideas must not be Overlooked.

The advertisement writer has been warned not to attach too much importance to what the manufacturer says about his goods. This does not mean that the latter is to be neglected. The manufacturer knows many valuable things about his goods that nobody else knows. It is his sense of values that is often wrong. Manufacturers (particularly of machines and equipment) are prone to emphasise some little touch of mechanical ingenuity, some novel application of an engineering principle, some constructional detail of theoretical interest.

Thus, one manufacturer who insists on writing his own advertisements recently published an advertisement of some little household novelty, and made great use of the fact that "by the ingenious application of the well-known principle of ——, two pawls working in conjunction with ——," and so on (quoting from memory). What earthly interest has a housewife in the working of two pawls and a number of other gadgets? If she even knows what a pawl is, it would be surprising. The author himself does not know for sure. This manufacturer was primarily an engineer, and he looked at his product from the engineer's point of view, with the result indicated. To him the pawls and their working were the most interesting things about his product. But the advertisement writer must not jump to the conclusion that he is right in ignoring mechanical details of this kind.

Concentrate upon Results.

The manufacturer was on the right track in stressing his pawls, but he was in the wrong vehicle. The point is that these pawls and their working produced a definite result, the smoother working and greater safety of the appliance. Furthermore, they constituted an important difference between this product and its rivals. What the advertisement writer must do, in such a case, is to *concentrate first upon the better result produced* by this engineering ingenuity, and after rubbing that well in, to explain in simple, non-technical language, by means of analogy and illustration, just how the result was obtained. In this way an arresting, interesting and convincing advertisement can be written. The manufacturer's technical knowledge must be extracted, analysed, and turned into readable selling points and good advertisements.

Consult the Consumer.

A further fruitful source of ideas for advertisements lies in the persons to whom one is trying to sell the product. Certain advertisers try to obtain the consumer's interest by introducing the words "you" and "your" into their text, imagining that they have satisfactorily touched his imagination by this. This is a feeble substitute for the genuine appeal to the consumer. "Buy *your* boots at Brown's" has no real personal appeal. It is a mere impersonal injunction, and is recognised as such.

The following questions should be asked and answered by the advertisement writer: (1) What does the consumer want the product to do for him? (2) How does he think it ought to do what it wants? (3) What does he use the product for? and (4) What does and can he expect to gain by changing over to the advertiser's particular make?

It must be realised that the customer himself, with his personal needs, desires, hopes, fears, vanities, aspirations and dislikes, is one of the most productive sources of advertisement ideas.

This section has stressed primarily the analysis of the product as a source of advertisement ideas, and the necessity of sincerity as a basis for the writing of advertisements. The actual mechanics and laws for advertisement writing are discussed at length in many sound and comprehensive text-books on the subject, and it is not intended to make this article either compete or compare with the full-dress treatises. What the author has sought to do is to give the reader a grasp of the main principles underlying the art of advertisement writing. For such information as he needs on the subject of the manner of writing he is referred to the section on "Sales letters" which opened this series. Much of what is there written can be applied with equal force to the writing of advertisements. One may only add that of all powers, the power of condensation is the most important to the advertisement writer. His, indeed, is the task of saying much in little.

(*To be continued.*)

Commercial Tests for Cast Iron.

(*Concluded from page 276.*)

that gentleman had shown in that and other work was a matter for sincere congratulation and thanks.

The Chairman, asking for further comments from members, said he was quite aware that it had been an address very full of matter for consideration, and no doubt they would be in a better position to discuss it after they had seen it in print in The Foundry Trade Journal.

Vote of Thanks.

Mr. W. Parker (Halifax), moving a vote of thanks to Dr. Swift and Mr. Nichols, said the lecture was one of the best the Branch had heard for a considerable time. He was sure the parent body would be very pleased to accept anything that Dr. Swift could put forward on those lines, because the test-bar question had been a vexed problem for all of them.

Mr. R. D. Welford (Bradford), seconding the motion, said Dr. Swift had so fully covered the ground that he had not left much room for argument. No test-bar could represent actually the casting that it was supposed to represent. Test-bars had been a bone of contention between founders and inspectors for as long a time as one could remember. This was one of the best lectures the Branch had ever had on the subject of commercial tests for cast iron. It emphasised the necessity for founders working under methodical control and analysis and casting at proper temperature. In olden times, when they had to mix and cast their iron by guess, they had any amount of variation in the bars and endless trouble. Dr. Swift's address would be an excellent one, he would suggest, to be presented at the annual conference of the Institute, so that it could be broadcast not only over Britain but also over the Continent and America. Then something might be done to make the tests conform more to the different sizes of castings, though it would never be possible to make them conform to all.

Dr. Swift suitably acknowledged the thanks of the meeting.

American Foundrymen's Association.

TENTATIVE PROGRAMME FOR THE CHICAGO CONVENTION.

Monday, May 4.

9.0 a.m.—Registration begins.

10.0 a.m.—Committee meetings.

12.0 noon.—Exhibition officially opens.

3.0 p.m.—*General Opening Meeting.* Presidential Address and "A Cross-Section of the British Foundry Industry," by Mr. Vincent C. Faulkner, Editor, THE FOUNDRY TRADE JOURNAL (Exchange Paper of the Institute of British Foundrymen).

4.30 p.m.—*Shop Operation Course*—Sand Control (1st session)—Moisture Control.

Tuesday, May 5.

9.0 a.m.—*Shop Operation Course*—Sand Control (2nd session)—Permeability and Fineness.

10.0 a.m.—*Grey Iron*—High-Test Alloy Cast Iron and Testing. "Manufacture and Use of Cupola High-Test and Alloy Irons in a Machine Tool and Jobbing Foundry," by Mr. L. M. Sherwin and Mr. T. F. Kiley, Brown & Sharpe Manufacturing Company, Providence, R.I.; "Testing Cast Iron," by Major Nicolau, Paris, France (Exchange Paper of French Foundry Technical Association); and "A New Type of Inclusion in Cast Iron and Its Relation to Manganese and Silicon Content," by Mr. F. J. Cook, Past-President, Institute of British Foundrymen.

10.0 a.m.—*Malleable*—Metals and Melting. "New High-Tensile Materials," by Dr. Anson Hayes, Industrial Furnace Corporation, Buffalo; "Thermal Balances of Melting Furnaces and Production Costs in Malleable Foundries," by Mr. J. H. Hruska, Berwyn, Ill.; "Report of Representative on Joint Committee on Refractories," by Mr. J. R. Allan, International Harvester Company, Chicago; and Reports of Committees.

10.0 a.m.—*Non-ferrous*—Foundry Costs. "Weak Points in a Cost System which Permit Leakages," by Mr. E. A. Baker, the E. A. Baker Corporation, New York.

10.0 a.m.—*Pattern Production*—Round-Table Meeting.

12.15 p.m.—*Malleable Division*—Luncheon and Round-Table Discussion.

2.0 p.m.—*Foundry Costs.* Report of Committee to Formulate Data which should be Supplied when Estimates are Requested, and Report of Committee on Methods of Determining Moulding Costs.

2.0 p.m.—*Sand Research.* "Shape of Sand Grains," by Dr. H. Ries and Mr. G. D. Conant, Cornell University, Ithaca, N.Y.; "Relation Between Sand Grains and Strength of Sand," by Dr. H. Ries and Mr. H. V. Lee, Cornell University, Ithaca, N.Y.; "Effect of Heat on Permeability of Facing and Core Sands," by Mr. W. M. Saunders, Providence, R.I.; "Some Observations on Use of Synthetic Sands," by Mr. L. B. Knight, National Engineering Company, Chicago; and Reports of Committees.

4.0 p.m.—*Shop Operation Courses.* Steel (1st session)—Shrinkage of Steel, Shrinkage Allowance, Distortion of Patterns, and Proper Heading and Gating. Grey Iron (1st session)—Cupola Practice. Malleable (1st session)—Melting Practice. Non-ferrous (1st session)—Fluidity and Shrinkage as Factors Affecting Gating.

Wednesday, May 6.

9.0 a.m.—*Shop Operation Course*—Sand Control (3rd session)—Bond Strength Control.

10.0 a.m.—*Grey Iron*—Melting Methods. "Melting Grey Iron and Malleable Iron in the Indirect-Arc Furnace," by Mr. J. H. Vogel and Mr. J. C. Bennett, York Ice Machinery Corporation, York, Pa.; "Electric-Process Iron for Cylinder and Cylinder-Head Castings," by Mr. H. E. Bromer, Standard Foundry Company, Racine, Wis.; "A Hot-Blast Cupola," by Mr. J. T. MacKenzie, American Cast Iron Pipe Company, Birmingham, Ala.; and "Effect of Excessive Atmospheric Moisture on Cupola Operation," by Mr. N. A. Moore, Piston Ring Company, Muskegon, Mich.

10.0 a.m.—*Non-ferrous*—Plant Methods. Report of Committee on Recommended Practices; "Improved Brass-Foundry Practice," by Mr. D. G. Anderson, Western Electric Company, Chicago; "Deep-Etching of Brass as Applied to Gating Problems," by Mr. R. W. Parsons, Ohio Brass Company, Mansfield, Ohio; "Cupola Melting of Brass," by Mr. T. Mauland, International Harvester Company, Chicago; and "Bronze Pressure Castings," by Mr. J. E. Crown, U.S. Naval Gun Factory, Washington.

10.0 a.m.—*Steel Founding*—Metallurgy. "Chemical Composition as Employed for Classifying Carbon and Alloy Steels for Castings," by Major R. A. Bull, Electric Steel Founders' Research Group, Chicago; "Some Metallurgical Points in Acid Open-Hearth and Electric Steel for Castings," by Mr. F. A. Melmoth, Detroit Steel Casting Company, Detroit; and Reports of Committees.

12.15 p.m.—*Steel Division*—Luncheon and Round-Table Discussion.

12.15 p.m.—*Non-ferrous Division*—Luncheon and Round-Table Discussion.

2.0 p.m.—*Apprentice Training.* "Getting a Community Apprenticeship Programme Under Way," by Mr. H. S. Falk, Falk Corporation, Milwaukee; and "Related Instruction," by Mr. S. M. Brah, Tri-City Manufacturers' Association, Moline, Ill.

4.0 p.m.—*Shop Operation Courses.* Steel (2nd session)—Cleaning Room Practice. Grey Iron (2nd session)—High-Test Iron. Malleable (2nd session)—Moulding Practice. Non-ferrous (2nd session)—Gating Practice with Reference to Aluminium-Bronze, Manganese-Bronze, Yellow Brass and Nickel Alloys.

Thursday, May 7.

9.0 a.m.—*Shop Operation Course*—Sand Control (4th session)—Sand Losses.

10.0 a.m.—*Grey Iron*—General Practice. "Factors Which Influence the Surface Quality of Grey-Iron Castings," by Mr. W. G. Reichert and Mr. D. Woolley, Singer Manufacturing Company, Elizabeth, N.J.; "The Microscope as a Tool in Investigating Cast Iron," by Mr. R. M. Allen, Bloomfield, N.J.; "Gates," by Mr. M. Kuniansky, Lynchburg Foundry Company, Radford, Va.; "A Contribution to the Study of the Part Played by Phosphorus in Cast Iron," by Mr. J. Dessent and Mr. M. Kagan, Liége, Belgium (presented on behalf of Belgian Technical Association); and "The Effect of Soaking Time on Initial Temperature and Analysis," by Mr. W. H. Spencer and Mr. M. M. Walding, American Cast Iron Pipe Company, Birmingham, Ala.

10.0 a.m.—*Non-ferrous*—Plant Practice. "Moulding Practice for Heat-Treated Aluminium-Alloy Castings," by Mr. L. H. Fawcett, U.S. Naval Gun Factory, Washington; "The X-Ray as a Tool for Improving Aluminium-Alloy Foundry Practice," by Mr. H. J. Rowe and Mr. E. M. Gingerich, Aluminum Company of America, Cleveland; and "Permanent-Mould Foundry Practice for Bronze Castings," by Mr. Henri Marius, Lenoir Car Works, Lenoir City, Tenn.

10.0 a.m.—*Steel*—Plant Practice. "A Comparison of Synthetic and Natural Bonded Moulding Sands for Steel Foundries," by Mr. H. J. Cole, General Electric Company, Schenectady; "Inter-relationship of Pin-Hole Trouble and the Low-Ductility Problem," by Mr. George Batty, Steel Castings Development Bureau, Philadelphia; and "Detecting Casting Defects by Radiography, Using Gamma Rays," by Mr. C. W. Briggs and Mr. R. A. Gezelius, Naval Research Laboratory, Anacostia, D.C.

2.0 p.m.—*Business Meeting.* Reports of Officers and Committees; and "Centrifugal Casting of Guns," by Colonel T. C. Dickson, Watertown Arsenal, Watertown, Mass.

4.0 p.m.—*Shop Operation Courses.* Steel (3rd session)—Heat-Treating Practice. Grey Iron (3rd session)—Gates and Risers. Non-ferrous (3rd session)—Gating Practice as Related to Red Brass and Aluminium Alloys.

Institute of British Foundrymen.

ANNUAL MEETING OF LANCASHIRE BRANCH.

The annual general meeting of the Lancashire Branch of the Institute of British Foundrymen was held last Saturday at the Manchester College of Technology, Mr. R. W. Stubbs presiding. The financial statement showed that the subscriptions received during the year amounted to £826 17s. 6d., of which £27 6s. had been paid direct to the general secretary. The Branch Expenses Account showed receipts of £153 19s. 10d., including £45 19s. brought forward from the previous year. The payments included printing and stationery, £42 7s. 6d., and grants of £10 and £7 to the Burnley and Junior Sections respectively. The total expenditure was £95 6s. 4d., leaving £58 13s. 6d. to be carried forward.

MR. GILPIN, hon. secretary, reported that the membership now numbered 305, a net loss of six during the year. It comprised 7 subscribing firms, 99 members, 187 associate members and 12 associates. Mr. Gilpin thought the attendance at the lectures had not been quite as good as in previous years, probably because of the bad-weather conditions on some occasions.

The election of officers resulted in the following:—*Branch-President*, Mr. R. W. Stubbs; *Senior Vice-President*, Mr. E. Flower; *Junior Vice-President*, Mr. A. Phillips; *Branch Council*, Mr. T. L. Beech, Mr. W. Gilpin, Mr. E. E. G. Grimwood and Mr. H. V. Grundy; *Representatives to General Council*, Mr. H. V. Grundy, Mr. J. Hogg, Mr. E. Longden, Mr. J. Masters, Mr. R. A. Miles and Mr. J. S. G. Primrose; *auditors*, Mr. A. Hopwood and Mr. R. A. Jones; *honorary secretary*, Mr. J. E. Cooke; *assistant honorary secretary*, Mr. R. C. Hargreaves.

Approval was given to a proposal that the senior auditor shall retire at the end of the twelve months and not be eligible for immediate re-election. It was decided to send a recommendation to the General Council that the bye-laws be amended so that the chairman of the Junior Section shall be *ex officio* a member of the Branch Council. MR. W. JOLLEY stated that he had given notice to the general secretary that he would propose that the Branch representatives on the General Council shall retire at the end of a given term, and not be eligible for immediate re-election. He explained that the object was to give an opportunity for new men to come forward.

Further Discoveries of Manganese Ore in South Africa.—Rich deposits of manganese ore have been found within 200 miles of Durban. Samples have been assayed, and seem to indicate that the Mn content is up to 50 or 60 per cent. The deposits are within 20 miles of the railway and near water-power and coal. Exports from the Postmasburg fields for the month of 24 working days have reached 23,000 tons.

Trade Talk.

Messrs. E. A. Herbert & Company (Birmingham), Limited, metal merchants, have removed their London office from 104, High Holborn, to 121, Kingsway, W.C.2.

A scheme involving the lowering of the floor area of No. 3 graving dock at Govan, at a cost of £32,000 was approved by the Clyde Navigation Trustees at a meeting last week.

Messrs. Alfred Herbert, Limited, Coventry, have been appointed sole agents for the sale of Zeiss fine-measuring instruments in Great Britain, Northern Ireland and the Irish Free State.

Messrs. Swan, Hunter & Wigham Richardson, Limited, of Wallsend, have secured an order for a 7,000-ton oil tanker for the Burma Oil Company, of Glasgow. Work will be commenced at once.

The Board of Trade has laid before Parliament a new draft Order-in-Council to require imported electricity meters of certain descriptions to bear an indication of origin on importation into and on sale, or exposure for sale, in the United Kingdom.

The British Aluminium Company, Limited, is apparently the only British concern to have taken space at the exhibition held in connection with the Chicago Congress of the American Foundrymen's Association, which is to be held from May 4 to May 7 at the Hotel Stevens.

Mining & Industrial Equipment, Limited, 11, Southampton Row, London, W.C.1, report new orders for a Hum-mer screen for screening fireclay and a Raymond pulveriser for grinding ochres, for use in England, and a Rovac filter for experimental use in filtering ores in Brazil.

The torpedo-boat destroyer "Beagle," built by Messrs. John Brown & Company, Limited, Clydebank, has carried out trials on the Clyde. The Admiralty are sending this destroyer to Glasgow in connection with Civic Week demonstrations in June. The water-carrying tug "Colocolo," built for the Chilean Naval Commission by Messrs. Bow, McLachlan & Company, Limited, Paisley, has also completed successful trials.

The London & North Eastern Railway report that orders for 40,000 tons of steel rails have been placed with the undermentioned firms:—Dorman, Long & Company, Limited, Middlesbrough; Cargo Fleet Iron Company, Limited, Middlesbrough; Pease & Partners, Limited, Saltburn-by-the-Sea; S. Fox & Company, Limited, Sheffield; Colvilles, Limited, Glasgow; and the Steel Company of Scotland, Limited. With a view to obtaining better wearing results from the steel, the L.N.E.R. have adopted as their standard a rail containing a higher percentage of manganese than hitherto. The rails now ordered will conform to this standard.

The annual general meeting of the Carron Works Recreation Club was held on April 8, Mr. M. H. Metcalfe presiding. The report of the year's working showed the club to be in a healthy condition, and that unusual activity had characterised the season. A good membership had been recorded and the various facilities afforded in the club room had been fully appreciated. Office-bearers for the ensuing season were elected, and during the evening Mr. George Pate, O.B.E., general manager of the company, presented a gold albert to Mr. M. H. Metcalfe, president of the club, and a wireless set to Mr. W. Lightbody, secretary, as tokens of appreciation of services rendered to the club. The recipients suitably replied.

The Morgan Crucible Company, Limited, Battersea, London, S.W.11, have received an order for three oil-fired Morgan's patent tilting crucible furnaces of 15 cwts. (brass) capacity for Russia. They have also received a repeat order from an English firm for three similar 15-cwt. (brass) capacity furnaces for the melting of aluminium alloys; the firm in question will now have a battery of six furnaces of this size. Since their introduction, three years ago, 38 of these large oil-fired tilting crucible furnaces have been supplied by the Morgan Crucible Company in England, Italy, Belgium, Spain and Russia. The furnaces are attracting particular attention by their ability to melt efficiently, quickly and economically. A charge of 5 cwts. of aluminium can be melted in 45 minutes from a hot start, the oil consumption being 11 per cent., and a crucible life of over 200 heats has been obtained.

Asbestos boiler lagging, pounded to a powder and made into a putty with cylinder oil, can be used for making a mould when babbitting bearings.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Foundry Research Work.

To the Editor of The Foundry Trade Journal.

Sir,—I should like to correct a misapprehension which might arise in the minds of your readers, relating to the work of the Cast Iron Research Association, from some comments made by Mr. F. C. Edwards in a Paper in your issue of March 19, page 207. He says:—

"For instance, the several research associations connected with the industry appear to be almost exclusively employed in carrying out research work on metal, as metal."

A review I contributed to your issue, dated January 15, page 57, opens as follows:—

"Although the title of the British Cast Iron Research Association might be taken to refer only to the metallurgical aspects of cast iron, the Association has, as a matter of policy, always included in its scope the study of the whole of the technical side of the founding industry, not merely the products, grey iron, white and chilled iron, maleable iron, but the raw materials used in the industry, foundry pig-iron, sands, refractories, blackings, plumbagoes, its plant and equipment, such as cupola furnaces, and its methods and processes."

Furthermore, one of the investigations now in progress and arising out of which several Papers have been contributed to various technical societies is "The Strength of Cast Iron in Relation to Design." This is Investigation No. 7 in our last annual report.—Yours, etc.,

J. G. Pearce,
Director.

The British Cast Iron Research Association,
24, St. Paul's Square,
Birmingham.
April 14, 1931.

Company Meeting.

British Aluminium Company, Limited.—The annual meeting of the British Aluminium Company, Limited, was held recently. Mr. R. W. Cooper (chairman), who presided, said that the year began propitiously for their industry, remaining favourable until the second half, when the industrial depression throughout the world began to make itself felt on their volume of trading, and resulted, in the last quarter of the year, in a reduction of the basic price of the metal. They were, therefore, not immune from the fall in the prices of non-ferrous metals which occurred in 1930, but the fall in the price of aluminium was not nearly so severe as the reduction which occurred in other metals. With the decline of consumption, competition became still more acute, particularly for metal in semi-manufactured forms, consequently prices also fell on that side of their business. To meet the existing economic conditions, which could only be regarded as temporary, they had partially curtailed production at some of their works, but their operations continued on an economical basis, and they were in a position to take immediate advantage of any improvement in trade.

New Companies.

Wm. Rowan & Sons, Limited, 32, Park Lane, Mile End, Glasgow.—Capital £3,000. Ironfounders, etc. Directors: J. F., R. M. T. and W. Rowan.

Nelco, Limited, 15, Caroline Street, London, W.C.—Capital £6,000. Engineers, founders, etc. Directors: L. Murphy, G. N. White and E. T. Cook.

S. Russell & Sons, Limited, Bath Lane, Leicester.—Capital £85,000. Brass and iron founders, etc. Directors: S., S. H., W. S., G. and P. A. Russell and W. Hallam.

Obituary.

The death occurred at his home in Bridge of Weir recently of Mr. John Steel, managing director of the Caledonian Foundry, Greenock.

Mr. William Boyes Richardson, managing director of Messrs. Richardson, Tuer & Company, Limited, Hope Foundry, Farnworth, Bolton, a member of the Grand Council of the Federation of British Industries, died suddenly on April 1, aged 65.

Personal.

Sir Arthur N. L. Wood has been elected chairman of Messrs. A. Reyrolle & Company, Limited, Hebburn, in the place of the late Mr. Arthur Scholefield.

Wills.

Royds, C. D., a director of the Marbella Iron Ore Company, Limited, London, E.C.2 ... ... £9,333

Sankey, F. E., of Wolverhampton, a director of Messrs. Joseph Sankey & Sons, Limited, Bilston £45,753

Dorman, Sir Arthur J., Bt., of Grey Towers, Nunthorpe, chairman of Messrs. Dorman, Long & Company, Limited, Middlesbrough £132,173

Education Conference.

At a week-end conference held by the Board of Education at Loughborough, from April 10 to 13, for engineering teachers in technical schools and institutions, a lecture was given by Mr. E. R. Briggs, of Rugby, chairman of the Advisory Committee of the Institute of British Foundrymen and City and Guilds of London Institute, on "The Problem of the Founding Industry." Subsequently, Mr. J. G. Pearce, director of the Cast Iron Research Association, spoke on "What the Foundry Apprentice Needs." Active discussions followed, contributions being made in each case by Mr. S. H. Russell, of Leicester, Past-President of the Institute of British Foundrymen, and vice-chairman of the Advisory Committee of the Institute of British Foundrymen and City and Guilds of London Institute. The object of these lectures was to put before teachers in technical institutions the recent developments in foundry education and thereby promote the formation of courses for foundry students during the coming winter.

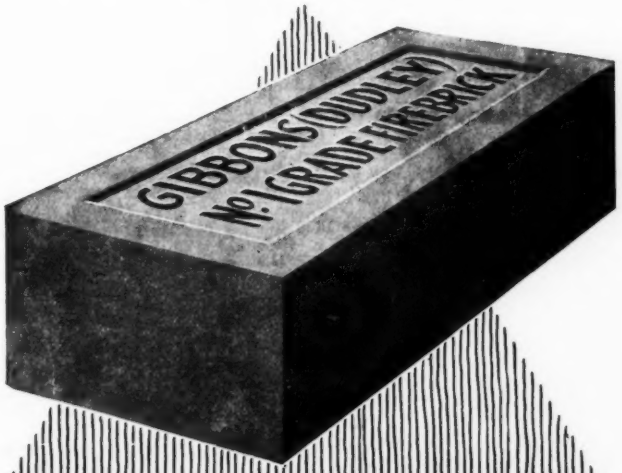
New Industries for the Clyde.

In an article by Mr. Sam Mavor in the current issue of "M. and C. Apprentices' Magazine," the house journal of Messrs. Mavor & Coulson, Limited, Glasgow, it is stated that "The establishment of new industries is easy to talk about, but less easy to put in practice, and it can seldom be achieved at a stroke; it is rather a gradual process of patient building up—the development of production and of marketing growing hand-in-hand." Dealing with the new works to be opened by the firm at Kirkintilloch for the manufacture of electrical switchgear, Mr. Mavor says that in the West of Scotland there is a large market for apparatus of the kind to be produced at Kirkintilloch; this home market will be intensively cultivated, and will be the foundation on which to extend the firm's export trade.

Manganese Steel Rails.—Commenting on the statement that the Great Western and other railways in this country are contemplating the more extensive use of manganese-steel rails, the "Bergwerks-Zeitung" remarks that in Austria a stretch of track laid with these rails has been in operation for the past two years.

Right from the mining of the clay

GIBBONS (Dudley) Ltd., have been making Refractories for 97 years. They control the manufacture of their products right from the mixing of the clay, and each stage of production is so closely supervised that an unvarying high standard of quality is definitely assured. A comprehensive range of Refractories is available —including Carborundum, Corundum and Sillimanite; a Technical Service Department offers whole-hearted co-operation with every customer for the solution of his particular Refractory problem. A complete catalogue will be forwarded on request or a representative will gladly keep any appointment.



GIBBONS' REFRACTORIES

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Phone: Victoria 0128. (Adjacent Westminster Tube Station.)

Street's

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—A certain improvement, small but at least satisfactory, can be discerned in the state of trade in this area. Most of the consuming works have very little iron in stock, as they have been buying on a hand-to-mouth basis for a long time past. Now they are beginning to make a few tentative purchases for a few weeks ahead, although, of course, the prospect of the Budget tends to make buyers cautious. A few sales of Cleveland iron to Scotland are reported, although there can be no serious hopes of expansion in that area so long as Continental and Indian iron is offered at such low prices. Fortunately, the fall of foreign iron prices seems to have been checked, and a slight advance might give an immediate impulse to the consumption of Cleveland foundry grades. Local consumers are taking regular deliveries, but the bulk of the iron now being produced is going into direct consumption at the steelworks, and the requirements of the latter still tend to increase. Stocks of iron are consequently low, with prices firm, and any further expansion in the consumption would probably necessitate an increase in output. Current transactions, mainly for April delivery, are based on the following prices :—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

There is perhaps less cause for satisfaction in the hematite market, although more confidence is shown in the outlook. Despite the fact that makers have shown a disposition to cut prices to get rid of current output and avoid the expense of taking iron into stock, they will only take forward contracts at rather higher prices than those now ruling, and preparations are being made to restart two more hematite furnaces next month. Consumers are delaying forward purchases, but they are watching the market very closely, and it is believed that some big orders will shortly be released. Meanwhile, makers are selling East Coast mixed numbers at 66s. 6d. and No. 1 quality at 67s. Rather lower figures have been accepted for export, but local makers are imposing upon merchants a condition that they should not sell to home consumers below a fixed price. Bessemer mixed numbers in the North-West of England are unchanged at 68s.

LANCASHIRE.—Little interest was taken in the market this week, but sellers are hoping that the improvement of recent weeks will be maintained. Unfortunately, most of the leading textile-machinery concerns are working short time. The machine-tool trade, however, is in a better position, and some of the general foundries are better engaged than they have been lately. Renewed interest in new business should be shown now, as the early part of the month has become the recognised buying period. There has been little change in prices. For delivery to users in the Manchester price zone, Staffordshire and Derbyshire brands of No. 3 are at 69s. 6d. per ton, with forge quality at 64s. 6d., Northamptonshire foundry iron at 68s., North-East Coast iron at the Midland zone rates, Scottish brands at from about 89s. to 90s., and West Coast hematite iron at around 82s. 6d. per ton.

MIDLANDS.—Both the light and heavy foundries are affected by the fact that consumers themselves are short of work. At the moment there is little seasonal trade. The figures quoted by the furnaces for delivery to Birmingham and Black Country stations are 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—There is little inquiry for any kind of pig-iron. So far no change has been made in the price of foundry iron in this area. Scottish foundry iron being at 73s. 6d. per ton, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. Continental No. 3 can be obtained at 52s. 6d. f.o.t. Grangemouth, and Middlesbrough No. 3 at 60s.

Finished Iron.

The market remains quiet, trade generally showing little sign of improvement. Even the makers of Staffordshire marked bars are unable to operate regularly and are in urgent need of new work. Their price is unchanged at £12 10s. at works. The mills making crown and the cheaper grades of iron were idle all last week, and prior to Easter had been working for only two or three days a week. Crown bars are offered at from £9 5s. up to £10, according to specification, and nut and bolt iron at from £8 12s. 6d. to £8 15s. Little support can be given to the latter grade of iron except for urgent spot lots, as consumers are able to place the bulk of their business with Continental mills at very much lower rates. The foreign product is being quoted at about £4 15s. delivered works in South Staffordshire.

Steel.

Trade is scarce in most branches of the finished-steel trade. However, the railway orders for sleepers and rails given out in the last week or so have been very welcome, and in railway material generally there is now more activity. There is no sign of the shipbuilding industry needing increased quantities of steel in the near future, and the constructional engineers also are not busy. There is no improvement in the market for small steel bars, which are still subject to keen competition from the Continent at low prices. The market for semi-finished steel shows little improvement. The British makers on the whole are maintaining their prices, although they are subject to negotiation for any promising business. Continental prices are still tending towards higher levels. Some of the Continental mills are still off the market, declining to book at the current level of values.

Scrap.

Supplies of iron and steel scrap are plentiful in the Cleveland area, and prices are at very low levels. The quotation for ordinary-quality cast-iron scrap is 47s. 6d., while good machinery quality is worth 49s. In the Midlands the scrap market has been extremely quiet. Very little new business is being placed. The price of good heavy machinery cast-iron scrap in cupola sizes is 57s. 6d., and light cast iron is at 37s. 6d. The Scottish market is similarly placed. No improvement is shown, little or no business being transacted. The prospects are not bright. Prices generally are unchanged. First-class machinery metal, in pieces not exceeding 1 cwt., is quoted at 50s. to 52s., while ordinary cast-iron scrap to the same specification is at 47s. 6d. The above prices are all delivered consumers' works.

Metals.

Copper.—In New York there is talk of a further conference of producers on the subject of the regulation of output. The American statistics for March show that the refined production is slightly reduced, while the total deliveries substantially exceed the output, causing an appreciable decline in stocks. Sentiment has been somewhat strengthened by these figures, although it is contended that the American deliveries figures are rather misleading, and probably well in excess of actual consumption.

Closing quotations :—

Cash.—Thursday, £43 7s. 6d. to £43 8s. 9d.; Friday, £43 11s. 3d. to £43 12s. 6d.; Monday, £44 2s. 6d. to £44 5s.; Tuesday, £43 7s. 6d. to £43 8s. 9d.; Wednesday, £43 2s. 6d. to £43 5s.

Three Months.—Thursday, £44 1s. 3d. to £44 2s. 6d.; Friday, £44 3s. 9d. to £44 5s.; Monday, £44 15s. to £44 16s. 3d.; Tuesday, £44 to £44 2s. 6d.; Wednesday, £43 16s. 3d. to £43 17s. 6d.

Tin.—A fair amount of business has been done in America, where consumers have bought quite freely at the lower rates. The Continent also has displayed a certain amount of interest. The trade demand for tin is no worse, and it now remains to be seen whether the reduced production will be enough to improve the statistical position. The results of the quota scheme, however, cannot be expected to be apparent in the statistics at the end of April.

Official closing prices :—

Cash.—Thursday, £116 5s. to £116 7s. 6d.; Friday, £115 17s. 6d. to £116; Monday, £115 2s. 6d. to £115 5s.; Tuesday, £115 12s. 6d. to £115 15s.; Wednesday, £114 15s. to £114 17s. 6d.

Three Months. — Thursday, £117 15s. to £117 17s. 6d.; Friday, £117 5s. to £117 7s. 6d.; Monday, £116 12s. 6d. to £116 15s.; Tuesday, £117 2s. 6d. to £117 5s.; Wednesday, £116 5s. to £116 7s. 6d.

Spelter.—Conditions leave much to be desired. Consumers refuse to consider further purchases until orders for manufactured material show some increase. The Continental demand is fair.

Daily fluctuations :—

Ordinary.—Thursday, £11 17s. 6d.; Friday, £11 15s.; Monday, £11 18s. 9d.; Tuesday, £11 15s.; Wednesday, £11 11s. 3d.

Lead.—The movement of lead prices during the past few weeks has been erratic, and it has for some time been evident that the lead industry is passing through a very critical period. It is now believed that a comprehensive agreement on the subject of restriction of lead output has been practically achieved. No official statement has yet been made, but there is good reason to believe that an agreement on this question is being negotiated by Australia, Canada, Mexico, Spain, Germany and possibly Belgium. It is understood that the ratio by which production may be reduced is probably about 15 per cent. of the 1930 output, and it is thought that this restriction will bring the production within the present reduced rate of consumption, and stocks, except in U.S.A., will be drawn upon to the extent of perhaps 2,000 tons per month.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £12 3s. 9d.; Friday, £12 12s. 6d.; Monday, £13; Tuesday, £12 17s. 6d.; Wednesday, £12 15s.

Reports and Dividends.

Robert Stephenson & Company, Limited.—Dividend of 5 per cent. for the year.

A. Reyrolle & Company, Limited.—Net profit, £103,175; brought in, £74,680; ordinary dividend of 12½ per cent.; to reserve, £40,000; carried forward, £76,558.

Smith & McLean, Limited.—Net profit, £5,292; brought in, £1,876; preference dividend takes, £4,765; no ordinary dividend; carried forward, £19,287.

Bede Metal & Chemical Company, Limited.—Profit, £22,008; brought in, £6,439; final dividend of 1s. per share, making 1s. 6d. per share; to reserve, £8,000; carried forward, £7,361.

Hadfields, Limited.—Profit, £43,085; brought in, £92,295; directors' fees, etc., £2,525; debenture interest, £57,153; preference dividend, £13,500; carried forward, £62,202.

Harrison (Birmingham), Limited.—Net profit, £50,536; brought in, £20,822; dividend on the ordinary shares of 20 per cent., tax free; to reserve, £20,000; carried forward, £21,220.

Baldwins, Limited.—Profit, £300,905; brought in, £27,893; depreciation, £80,000; special expenditure at collieries, £12,911; net credit balance, after meeting income-tax and debenture-interest charges, £19,191; to general reserve, £20,000; carried forward, £27,084.

British Thomson-Houston Company, Limited.—Profit, £462,446; brought in, £205,262; interest charges, £130,848; depreciation, etc., £160,988; net profit, £169,310; preference share dividend, £81,374; dividend of 5 per cent. on the ordinary shares; carried forward, £215,698.

Safety First.—Every machine operator should be well informed as to how safely to stop his machine in an emergency.

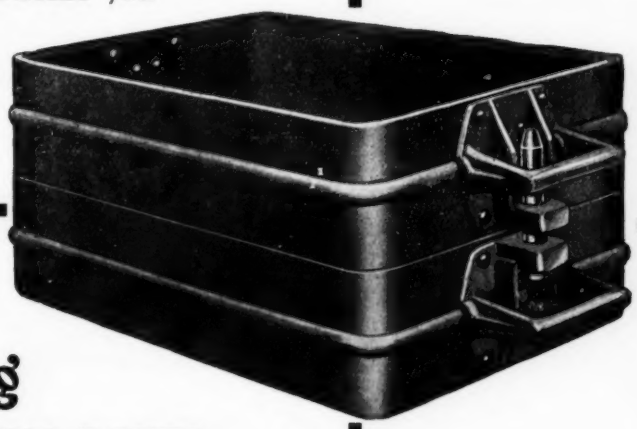
Reduction of Iron Oxides by Carbon.—Experiments by H. H. Meyer, reported in the Mitteilungen of the Kaiser-Wilhelm Research Institute, show that the reduction of the oxides of iron by carbon takes place in definite steps in the absence of oxygen. The temperatures at which the different reactions occur are widely separated, thus differing from those in the reduction by carbon monoxide or by hydrogen. Thus the difference in temperature between the reduction of ferric oxide and that of the magnetic oxide is 300 to 370 deg. C., according to the kind of carbon used, while that between the reduction of magnetic oxide and ferrous oxide is about 100 deg. C. The actual temperatures at which the reductions commence vary by about 150 deg. C. for the various sorts of carbon. The reduction of ferric oxide to the magnetic oxide is so complete that it can be used to determine the quantity of ferric oxide contained in mixtures of the oxides, even in the presence of metallic iron.

MORE FOUNDRIES USE STERLING BOXES!

The continued and increasing popularity of the Sterling Moulding Box in the foundries of this country is convincing proof that the STERLING Solid Ribbed Rolled Steel BOX has more than justified itself as

THE GREATEST ECONOMY YOU CAN INTRODUCE INTO YOUR FOUNDRY.

To-day the need for economy is greater than ever before. If therefore you are not a user of STERLING BOXES you should write for our latest catalogue and investigate the Sterling Service without delay.



Sterling

FOUNDRY MOULDING BOXES
FOUNDRY WHEELBARROWS
CORE OVEN TRUCKS
PATTERN PLATES & ODDSIDES
STEEL BOTTOM PLATES
MOULDING BOX PINS

STERLING FOUNDRY SPECIALTIES Limited
LONDON OFFICE:—13 VICTORIA STREET, S.W.1
AGENTS AT MANCHESTER, GLASGOW & NEWCASTLE-ON-TYNE.
BEDFORD

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	43	2	6
Three months	43	16	3
Electrolytic	46	0	0
Tough	44	0	0
Best selected	44	10	0
Sheets	77	0	0
India	56	10	0
Wire bars	47	12	6
Do., May	47	12	6
Do., June	47	12	6
Ingot bars	47	12	6
H.C. wire rods	49	0	0
Off. av. cash, March	44	17	2¼
Do., 3 mths., March	45	7	6 15/32
Do., Sttlmnt., March	44	17	4 7/17
Do., Electro, March	48	3	4 1/17
Do., B.S., March	46	9	8 3/8
Do., wire bars, March	48	12	10 1/17
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7d.

BRASS.

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	9¼d.
Rods, extd. or rlld.	5¼d.
Sheets to 10 w.g.	8¼d.
Wire	8¼d.
Rolled metal	7¾d.
Yellow metal rods	5¼d.
Do. 4 × 4 Squares	6d.
Do. 4 × 3 Sheets	6¼d.

TIN.

	£	s.	d.
Standard cash	114	15	0
Three months	116	5	0
English	115	15	0
Bars	118	15	0
Straits	118	2	6
Australian	117	2	6
Eastern	118	0	0
Banca	118	12	6
Off. av. cash, March	121	18	4 1/17
Do., 3 mths., March	123	8	4 5/32
Do., Sttlmt., March	121	18	2 7/17

SPELTER.

	£	s.	d.
Ordinary	11	11	3
Remelted	10	12	6
Hard	9	5	0
Electro 99.9	14	0	0
English	12	2	6
India	11	0	0
Zinc dust	19	10	0
Zinc ashes	2	15	0
Off. aver., March	12	8	7 13/16
Aver. spot, March	12	3	9 15/32

LEAD.

	£	s.	d.
Soft foreign ppt.	12	15	0
English	14	10	0
Off. average, March	13	4	9 11/32
Average spot, March	13	2	6 15/32

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	21	0	0
Do., V.M. ex-whf.	20	0	0
Rods	23	0	0
Boiler plates	14	0	0
Battery plates	15	7	6

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	24	10	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 10 0
45/50%	£10 10 0
75%	£17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	1/8¼ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£29 0 0
4/6% car.	£21 0 0
6/8% car.	£19 17 6
8/10% car.	£19 12 6
Ferro-chrome—	
Max. 2% car.	£30 5 0
Max. 1% car.	£34 0 0
Max. 0·70% car.	£36 5 0
70% carbon-free	10d. lb.
Nickel—99% £170 0 0 to	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 0 0
76/80% packed	£12 0 0
76/80% export	£ 9 0 0
Metallic manganese—	
94/96% carbonless	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales	£	s.	d.		£	s.	d.
Heavy steel	2	6	6	to	2	7	6
Bundled steel and shrngs.	1	17	6	to	2	2	6
Mixed iron and steel	1	17	6	to	2	1	0
Heavy cast iron	2	7	6	to	2	8	0
Good machinery for foundries					2	12	6

Cleveland—							
Heavy steel					2	2	6
Steel turnings					1	10	0
Cast-iron borings					1	5	0
Heavy forge					2	15	0
W.I. piling scrap					2	11	6
Cast-iron scrap	2	7	6	to	2	9	0

Midlands—							
Light cast-iron scrap					1	17	6
Heavy wrought					2	17	0
Steel turnings						—	

Scotland—							
Heavy steel					2	5	0
Ordinary cast iron					2	7	6
Engineers' turnings					1	12	6
Cast-iron borings					1	13	6
Wrought-iron piling					2	12	6
Heavy machinery					2	11	0

London—Merchants' buying prices delivered yard.

Copper (clean)					37	0	0
Brass					26	0	0
Lead (less usual draft)					10	0	0
Tea lead					7	0	0
Zinc					6	0	0
New aluminium cuttings					50	0	0
Braziery copper					34	0	0
Gunmetal					35	0	0
Hollow pewter					76	0	0
Shaped black pewter					56	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	67/-
Hematite M/Nos.	66/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	75/-
„ d/d Birm.	86/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
„ No. 4 forge*	66/-
„ No. 3 fdry.*	71/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	62/6
„ fdry. No. 3*	67/6
„ fdry. No. 1*	70/6
Derbyshire forge*	66/-
„ fdry. No. 3*	71/-
„ fdry. No. 1*	74/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/-
„ No. 3	73/6
Hem. M/Nos. d/d	72/-
Sheffield (d/d district)—	
Derby forge	61/-
„ fdry. No. 3	66/-
Lincs forge	—
„ fdry. No. 3	66/-
E.C. hematite	81/6
W.C. hematite	84/6
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
„ fdry. No. 3	69/6
Staffs fdry. No. 3	69/6
Northants fdry. No. 3	68/-
Cleveland fdry. No. 3	69/6
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	89/- to 90/-
Glengarnock, No. 3	—
Eglinton, No. 3	89/- to 90/-
Gartsherrie, No. 3	89/- to 90/-
Monkland, No. 3	89/- to 90/-
Shotts, No. 3	89/- to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	0	0	to	10	10	0
Nut and bolt iron	8	12	6	to	8	15	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					14	5	0

Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	10	5	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)	7	2	6	to	7	15	0
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to	9	10	0
Black sheets, 24g.	8	10	0	to	9	10	0
Galv. cor. shts. 24g.					11	0	0
Galv. flat sheets					11	10	0
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	5	5	0	to	5	12	6
Billets, hard	7	2	6	& up.			
Sheet bars	5	0	0	to	5	12	6
Tin bars	5	0	0	to	5	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11½d.
Sheet to 10 w.g.	1/-
Wire	1/1
Rods	1/-
Tubes	1/7
Castings	1/-

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.76
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	12.00
Basic	18.26
Bessemer	18.76
Malleable	18.76
Grey forge	17.76
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.65
Skelp, sheared steel	1.65
Steel hoops	1.70
Sheets, black, No. 24	2.35
Sheets, galv., No. 24	2.90
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
„ furnace	15/- to 17/-
Durham and Northumberland—	
„ foundry	13/6 to 14/-
„ furnace	13/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	15/-	to 15/3
„	28×20 „	30/-	to 30/6
„	20×10 „		21/10½
„	18¾×14 „		15/10½
C.W.	20×14 „		14/3
„	28×20 „		28/6
„	20×10 „		21/-
„	18¾×14 „		15/-
Terneplates	28×20		31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, st'l	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Apr.	9 ..	43	7	6	inc.	16/3
,,	10 ..	43	11	3	,,	3/9
,,	13 ..	44	2	6	,,	11/3
,,	14 ..	43	7	6	dec.	15/–
,,	15 ..	43	2	6	,,	5/–

Electrolytic Copper.

		£	s.	d.		
Apr.	9 ..	45	10	0	No change	
,,	10 ..	45	15	0	inc.	5/–
,,	13 ..	46	0	0	,,	5/–
,,	14 ..	46	0	0	No change	
,,	15 ..	46	0	0	,, ,,	

Standard Tin (cash).

		£	s.	d.		
Apr.	9 ..	116	5	0	inc.	47/6
,,	10 ..	115	17	6	dec.	7/6
,,	13 ..	115	2	6	,,	15/–
,,	14 ..	115	12	6	inc.	10/–
,,	15 ..	114	15	0	dec.	17/6

Tin (English ingots).

		£	s.	d.		
Apr.	9 ..	117	5	0	inc.	45/–
,,	10 ..	117	0	0	dec.	5/–
,,	13 ..	116	5	0	,,	15/–
,,	14 ..	116	15	0	inc.	10/–
,,	15 ..	115	15	0	dec.	20/–

Zinc Sheets (English).

		£	s.	d.		
Apr.	9 ..	21	0	0	No change	
,,	10 ..	21	0	0	,, ,,	
,,	13 ..	21	0	0	,, ,,	
,,	14 ..	21	0	0	,, ,,	
,,	15 ..	21	0	0	,, ,,	

Spelter (ordinary).

		£	s.	d.		
Apr.	9 ..	11	17	6	inc.	3/9
,,	10 ..	11	15	0	dec.	2/6
,,	13 ..	11	18	9	inc.	3/9
,,	14 ..	11	15	0	dec.	3/9
,,	15 ..	11	11	3	,,	3/9

Lead (English).

		£	s.	d.		
Apr.	9 ..	13	10	0	dec.	5/–
,,	10 ..	14	0	0	inc.	10/–
,,	13 ..	14	10	0	,,	10/–
,,	14 ..	14	5	0	dec.	5/–
,,	15 ..	14	10	0	inc.	5/–

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 4	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 1	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 11½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	86 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	90 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	89 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	—	—	—	—	—	—	—	—	—	—

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